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FLOOD CONTROL AND WATER CONSERVATION

THE leading article in *Nature* of August 15, p. 263, directed attention to the fact that, although the floods along the east coast of Britain and the London fog disaster had both produced official committees of inquiry to investigate and report upon the problems of tidal flooding and smoke pollution, no similar action followed the Lynmouth disaster in relation to the more frequent problem of river flooding. Correspondents ranging over a wide field of interests have raised numerous points in support of the committee of inquiry which the article advocated, and a reassessment of the problem is now made in the light of the communications received.

The first statement drew a distinction between periodic and episodic types of flooding. The periodic type is the fairly regular flooding related to a repetitive régime in the life of the river, conditions which local inhabitants normally expect from year to year. From time to time, however, exceptional circumstances of rainfall or snow-melt produce exceptional inundations, especially in the lower reaches of the larger river basins.

Episodic flooding, on the other hand, is related to abnormally heavy storms, and these although occurring infrequently in any one locality may cause much damage to property and occasion much loss of life as a result. Some notable historic cases were mentioned in the previous article, culminating in the Exmoor disaster of August 15, 1952, which caused twenty-eight deaths, and the loss of much of Lynmouth and seventeen bridges. Episodic flooding does not appear to be generally recognized yet as a frequent natural hazard in the meteorological conditions experienced by the British Isles—the infrequency in any one locality tends to mask the over-all picture. An examination of the records since the Lynmouth disaster will, however, serve to illustrate this point. A general consensus of opinion throughout Britain would probably regard the period which has since elapsed as fairly dry, with no memorable rainfall or flooding. As a fall of between two and three inches of rain in a day is regarded as exceptional and potentially dangerous (especially when falling on already saturated ground), it is interesting to find that the official records so far published reveal some sixty to seventy occasions of such heavy precipitation since the Lynmouth disaster. Of the local flooding caused by these occurrences, the most notable subsequent to the North Devon and North Somerset floods of August 15–16, 1952, included the serious flooding in Sussex on November 27, 1952; and that of May 24–25, 1953, in northern England and south-west Scotland, when there was much damage to roads and bridges, and some loss of life. The heavy June storms noted above were also responsible for severe flooding and considerable damage, several bridges being swept away in the Lake District. More recently, there has been loss of life, much damage and two bridges swept away in floods in the Afan Valley of Glamorganshire (August 20), while a bridge in the Troutbeck Valley of the Lake District, rebuilt after the June floods,

was demolished for a second time on August 31. Heavy falls of rain at the end of September again resulted in flooding in Langdale, and bridges were lost in the Lochaber district of Inverness-shire. November 1 saw heavy rainfall in southern England.

The picture revealed for the past year is repeated again and again in the past, and will clearly recur in the future. The records in "British Rainfall" reveal falls of from two to three inches of rain a day as a common occurrence, while four inches or more in one day can be expected at least once in every year somewhere in Britain, and a fall of six inches or more in one day occurs at least once somewhere in Britain in five years out of ten. It is true, of course, that many of these heavy rainfalls take place in normally wet districts; but no part of the country, on the basis of the available meteorological evidence, is completely immune from storms of potentially dangerous duration and intensity. Even in the wetter districts these heavy falls can be quite disastrous (for example, Rhondda Valley, November 11, 1929, Tweed Valley, August 12, 1948, and Exmoor, August 15, 1952). With our present meteorological and geomorphological knowledge, however, it would not be difficult to define and map those areas most susceptible to exceptional precipitation of the episodic type, and to demarcate those localities where damage is most likely to occur.

The possibility of flood control through various precautionary measures, including check dams and reafforestation, together with care in agricultural and industrial utilization of the land, is of course intimately linked to the wider problem of water conservation. Correspondents have been quick to point out that increasing demands are being made upon the water resources of Britain and that serious problems already exist in some areas. Hitherto regarded as an almost inexhaustible raw material, lack of water is now beginning to limit certain industrial undertakings. Electric power stations dependent on coal for energy need vast amounts of water for condenser units. An increasing population and a rising standard of living involve an increasing consumption of water. In the Midlands and east and south-east England, the demand now nearly equals the available supply from surface and underground sources.

Looking farther ahead, the possibility on a large scale in Britain of the controlled growth of crops and grass by summer irrigation (already demonstrated by successful experiments at Rothamsted Experimental Station) may produce further exceptional demands for water. The amount needed by the land to obtain maximum cropping can now be calculated with reasonable accuracy, and for a dry summer in south-east England almost astronomical figures emerge—up to 250,000 gallons per acre could be usefully applied. The possibility of large demands on water supplies by atomic energy and power stations must also be taken into consideration. All these trends may in time completely alter our conventional attitude towards water, and the conservation of much more, if not all, of our supplies may become imperative. Flood control need not therefore be regarded as a wholly negative, non-productive precautionary measure to avoid loss of life and structural damage to roads, railways and bridges, but as a vital link in the conservation of one of our most valuable assets.

Actions and decisions, however, need to be based upon sound and accurate information. We have adequate rainfall data from the Meteorological Office, details of underground water supplies are known to the Geological Survey, and reasonable historical records of exceptional floods also exist. But there is a regrettable deficiency in hydrological data, which has been accentuated by the unfortunate suspension of the Inland Water Survey in June 1952 on the grounds of economy. The Survey had the responsibility of initiating the development of a systematic and comprehensive network of surface-water gauging stations, together with the publication of hydrometric data: it was started very largely as a result of pre-war representations to the Government by the British Association for the Advancement of Science and the Institution of Civil Engineers, and it became one of the responsibilities of the Ministry of Housing and Local Government. The suspension of the Survey was a strange *non sequitur* after the passing of the River Boards Act in 1948 and the adoption of the following resolution in August 1951 by the International Union of Geodesy and Geophysics: "The U.G.G.I., considering that a great many hydrological data are lost because in many countries there exists no central hydrological organization, recommends that the national committees in such countries should encourage their governments or other appropriate agencies to inaugurate such an organization or coordinating body".

Correspondents from both academic and engineering circles have directed attention to the lack of hydrological data—an essential link in the chain of information. Others have suggested the need for strengthening the river boards, which in some areas appear to exist in name only. The need of planning authorities for more detailed information, the desirability of broadening the knowledge of the civil engineer and providing a code of practice, and the question of flood-warning systems in dangerous areas have also been raised. The present wide dispersal of responsibility in Government circles and the lack of any policy with respect to flood control and water conservation (especially as revealed by the suspension of the Inland Water Survey) have also brought forth comment.

Some pre-war pioneer work of investigation already exists in the valuable report of a committee of the Institution of Civil Engineers, on floods in relation to reservoir practice. This committee was set up as a result of the passing of the Reservoirs (Safety Provisions) Act 1930, and it published an interim report in 1933. The time now seems opportune for a re-examination of the problem, and the now wider ramifications inevitably suggest the desirability of instituting a widely representative committee of inquiry to ascertain existing responsibilities and their limitations, to make such recommendations for immediate action as appear desirable, and to provide guidance for future policies with respect to flood control and water conservation.

SELECTION OF SIR HENRY DALE'S PAPERS

Adventures in Physiology

With Excursions into Autopharmacology. A Selection from the Scientific Publications of Sir Henry Hallett Dale. With an Introduction and Recent Comments by the Author. Pp. xvi+652. (London: Pergamon Press, Ltd., 1953.) £6 6s.

HISTAMINE, acetylcholine and noradrenaline are powerful drugs and naturally present in the body; discussions about them occupy a large proportion of the available time at meetings of the Physiological Society and the British Pharmacological Society. Drugs which oppose them or release them, enzymes which form them or destroy them and drugs which oppose the enzymes, can all be regarded as part of the subject of autopharmacology, which has provided the pharmacologists with a topic of general fundamental importance. Sir Henry Dale is both the father and the godfather of this subject. He was the first to recognize the importance of all these three substances and to make detailed studies of their actions, and he provided the subject with a name which is still less widely used than it might be.

A selection of thirty of Sir Henry's most important papers has now been published in a fine book with an introduction and recent comments on each paper by the author. The selection has been confined to those papers at the head of which Sir Henry's own name appears, and this limitation has led to the exclusion of papers from his laboratory to which he made important contributions without taking credit for them. There is, however, no lack of material, as is shown by the bibliography of 253 items included at the end of the book. The selected papers are those which have told exciting new chapters in two stories, the story of the chemical transmission of impulses at nerve endings and the story of the physiological function of histamine. Here are many famous tracings on smoked paper which are familiar in the text-books although their original source is not always realized. Here are new ideas, now generally accepted, put forward with the explicit clarity which made them immediately convincing. Here is an introduction which tells us how in 1904 Dr. Henry Dale at the age of twenty-nine decided to accept a research post under Mr. (later Sir) Henry Wellcome, and of how so many other men who were later to become famous joined him there, and of the accidents which they turned into great opportunities. Mr. Wellcome said that he wanted work of permanent value to science to be done in his laboratories, but that he would also be grateful if the study of ergot could be rescued from the morass into which it had fallen. Both these wishes were triumphantly fulfilled when the study of ergot provided the inspiration for so many fundamental physiological discoveries.

"Adventures in Physiology" contains penetrating comments on each paper, which turn an anthology into a connected story, filling in gaps, adding human interest, and showing how the tale has unfolded in more recent years. These comments show that the author's brain is still more active than most other people's brains, and that he can still help to clear the thoughts of those who seek to follow in his footsteps. He has little to regret except that he did not always succeed in foreseeing what no one else foresaw; the few mistakes he has made have been turned to good advantage and provided clues for new advances.

The book is well produced and will be preserved in all medical libraries as a model of the way in which scientific discoveries should be made, and of the way in which scientific papers should be written.

J. H. GADDUM

THE OUTPUT OF A UNIVERSITY

Alumni Cantabrigienses

A Biographical List of all known Students, Graduates and Holders of Office at the University of Cambridge, from the Earliest Times to 1900. Compiled by Dr. J. A. Venn. Part 2: From 1752 to 1900. Vol. 5: Pace–Spyers. Pp. iv+614. (Cambridge: At the University Press, 1953.) £10 10s. net.

THE first volume of "Alumni Cantabrigienses" appeared in 1922. The monumental task undertaken by the late Dr. John Venn and his son, Dr. J. A. Venn, now president of Queens' College, Cambridge, is drawing near completion. Of the six volumes allotted by Dr. Venn to Part 2, for which he has been alone responsible, only one further volume now remains to be published.

The present volume naturally repeats the main features of the previous volumes of Part 2: the great preponderance of clerics among the University graduates of the years 1750–1900 remains very marked. Many clergymen had distinguished careers, like George Augustus Selwyn, first Bishop of New Zealand, in memory of whom Selwyn College was founded. Others like Stanley P. Smith, one of the famous "Cambridge Seven", Charles Simeon, leader of an Evangelical group, and William Paley, of the "Evidences of Christianity", are remembered for different reasons. Curious side-lights are given on the lives and views of others: H. T. Robins, being suspicious of the wine he was preparing for communion, saved the lives of one or more of his congregation, but lost his own, by tasting it: it proved to be caustic soda.

Of the many distinguished scholars, only a few can be mentioned: W. Robertson Smith, a member of the Old Testament Revision Committee in 1875, E. H. Palmer, professor of Arabic, murdered by Arabs when on a secret mission in Egypt, Adam Sedgwick and William Ridgeway were all colourful personalities, as also was Richard Porson, who was regius professor of Greek for sixteen years but never resided in Cambridge during the tenure of his chair. Of a different type was S. G. Phear, Master of Emmanuel College, who retired from the mastership after twenty-four years of office—an action described by another and older head of a college as "a most immoral proceeding". Of schoolmasters, the names of Sanderson of Oundle and T. E. Page of Charterhouse stand out; Samuel Parr, who "flogged after the old fashion", H. S. S. Salt of Eton, who renounced flesh food, declaring his colleagues to be "but cannibals in cap and gown", and J. P. Plumptre, also of Eton, who stigmatized Catholic emancipation as "the wickedest thing since the Crucifixion", are mentioned here as typifying a different class of schoolmaster.

Politicians play a prominent part in the list of biographies. It may suffice here to mention three Prime Ministers of Britain—Pitt, Lord Palmerston and Perceval, who was assassinated in the lobby of the House of Commons—and two Commonwealth Premiers—Smuts and W. P. Schreiner. Another

name not forgotten is that of Charles Stewart Parnell. Many soldiers, both regular officers and, during the First World War, temporary officers, passed through the University: Colonel J. V. Scarlett led the charge of the heavy cavalry at Balaclava, routing two thousand of the enemy with his three hundred men; Major-General H. H. Rose did good service in the Indian Mutiny, and later was commander-in-chief in India and became a field-marshal. The Royal Navy is represented by Rear-Admiral H. R. Popham (who survived a court-martial and severe reprimand to become in due course a commander-in-chief) and by a number of naval chaplains; among these was Alexander Scott, chaplain to the *Victory* at Trafalgar.

Writers and journalists include Max Pemberton, Owen Seaman of *Punch* fame, and J. R. Scott of the *Manchester Guardian*. Up to 1900 commerce and industry drew on far fewer members of the University than during the past fifty years, when H. A. Roberts had organized the University Appointments Board. But, if we may judge from some hundred and twenty Fellows of the Royal Society in the list, the desire to improve natural knowledge did attract a number of students to the study of the sciences. The Fellows may be divided into three groups nearly equal in number—those elected on account of a distinguished career outside the range of the natural sciences and those belonging to the A and B sides of science. Members of the first group come mainly from the earlier years covered by the volume. The names of Rutherford and Sherrington, both presidents of the Society, stand out from the main body of the Fellows. Others who may be mentioned include George Paget, who introduced clinical examinations for medical degrees and was one of many distinguished physicians; also Hugh Percy, Duke of Northumberland, who presented to the University Observatory in 1835 the Northumberland telescope and dome, and L. W. (later Lord) Rothschild, who bequeathed his magnificent natural history collection to the British Museum. Finally, among the Fellows of the Royal Society brief mention must be made of the Hon. Charles Parsons, of turbine fame, and, by way of contrast, the Hon. F. J. Robinson (later Viscount Goderich and then Earl of Ripon), the "weakest Prime Minister who ever held office in this country".

It is evident from the long list of Fellows of the Society of Antiquaries how much knowledge of local antiquities throughout the country has been gained owing to their activities. Two accounts of individuals have caught the eye: R. N. Philipps is said to have originated the use in Cambridge of the light blue colours, and W. Purkis was remembered as "Mr. Union" because, as Bishop Watson complained, when the dinner hour was changed in 1762 from 12 to 3, "foolish dons, like William Purkis of Magdalene, talked of combining the scholar and the gentleman".

The world of sport must not be left out of account. E. Provis was winning cups in croquet tournaments in his ninetieth year; C. Powlett was on a committee revising the laws of cricket in 1774; of cricketers, Prince Ranjitsinhji must be named, and, of rowing men, F. I. Pitman. Other types of racing are represented by the Hon. C. S. Rolls, pioneer racing motorist and aeronaut, and by Sir J. Shelley, twice winner of the Derby. G. A. F. P. S. Smyth fought in the last duel in England, while the Marquess of Queensberry, of the 'Queensberry rules', represents boxing; C. Smyth made the first guideless ascent of Mont Blanc, and Benjamin Smith, the first Dissenter admitted to the degree of B.A., made important pioneer voyages in Arctic regions. Joseph Page left the Army to run a cattle ranch in Texas; he suggests to us John Penn, the last proprietor and hereditary governor of Pennsylvania, and L. Shadwell, the last vice-chancellor of England and president of the Society of Psychrolutes. F. J. M. Stratton

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AGRICULTURAL SANITATION IN ASIA

Health and Agriculture in China

A Fundamental Approach to some of the Problems of World Hunger. By James Cameron Scott. Pp. 279. (London: Faber and Faber, Ltd., 1952.) 25*s*. net.

EVEN those who are interested in the problems of the technologically backward or non-industrialized parts of the world, and those who are well informed on many aspects of these problems, tend to neglect the importance of agricultural sanitation. The significance of this for all populations living under conditions of traditional hygiene is great, but nowhere more so than in the Chinese culture-area, where for many centuries it has been customary to make use of human excreta as fertilizer for crops. As many observers have pointed out, this is an excellent practice from the point of view of agricultural chemistry, since it avoids the waste of plant nutrients and valuable soil constituents which goes on in modern civilization. Perhaps the high levels of Chinese populations would have been impossible without it. But it has also been evident, since the rise of modern medicine, that from the point of view of health it is a major hazard. For centuries China has been a flourishing area for a great many diseases, and it has been calculated that 40 per cent of this was fæces-borne.

In the present valuable book, by a Scottish soil scientist who went to China in 1936 under Baptist missionary auspices, detailed accounts are given of the investigations of a renowned team of scientific students who worked under the leadership of the American parasitologist, Dr. G. F. Winfield, and of whom the author was one. All aspects of the problem were studied and are described here with tables and photographs. The outstanding problem is that of composting excreta with vegetable waste in such a way as to produce a non-pathogenic fertilizing medium. In itself this is not so difficult to solve; but the economic handicap was that over most of the Chinese culture-area there is not sufficient vegetable waste, partly because progressive deforestation has removed alternative sources of fuel. Urgent measures were therefore necessary of re-afforestation with quickly-growing fuel trees, and of rail and road communications which should bring other fuel sources to the villages. The problem will also be eased when greater abundance of chemical fertilizers becomes available.

It appears that the ultimate objective of those who now guide agriculture and health services in China is the abandonment of the age-old system of using human excreta as manure. But this must be a long way in the future, and it is therefore sure that the work of Scott, Winfield and their Chinese collaborators is now finding wide application and close continued study. I was able to see at first hand a year ago the extraordinary progress in public health which has come about during the past few years in China: covered dust-bins in remote villages where no such

things had ever before been heard of, mosquito-netting on all windows, cleared drains and oiled swamps, an enormous increase in the production and use of vaccines. This can only have been possible through the full confidence and co-operation of the masses of the ordinary country people—necessary also for putting into practice the lessons which resulted from the work of the Chilu–Yenching group to which the author belonged. How good it would be if he could visit China again (as I feel sure he would wish), to see and advise on these applications in practice.

JOSEPH NEEDHAM

TREE-SPOTTING IN MALAYA

Wayside Trees of Malaya

By E. J. H. Corner. Second edition. Vol. 1: Text. Pp. vii+772. Vol. 2: Plates. Pp. v+228 plates+v. (Singapore: Government Printing Office, 1952.) 2 vols., 25 Malay dollars.

THAT a second edition of "Wayside Trees of Malaya" has been found necessary after a lapse of twelve years—five of them war years when sales must have been very low—is a measure of its popularity. This is not surprising, since if ever there was a book which made easy the path of getting to know the trees, this is it.

The book is divided into two volumes, of which Vol. 1 has four parts. Part 1 contains short discourses on the morphology of the various parts of the trees, shapes of the trees, ant-trees and buttress-trees, phenology, a sketch of the Malayan vegetation, and a valuable list of outstanding trees and where examples of these are to be found.

An elaborate set of keys to the families and some genera, largely based upon vegetative characters, with the subsidiary aid of colour of the latex, and flowers and fruits, makes up Part 2. So far as the reviewer has tested them, these keys are adequate, and demonstrate vividly how far one can proceed on the road to identification without flowering and fruiting characters. These keys look simple; but the knowledge upon which they are based is not picked up in books but is the accumulation of experience gained from many hours spent in the field, often at that time of day when "mad dogs and Englishmen" are the only figures in sight. These keys will sometimes fail, as all keys with a limited objective must fail; but we feel that this will be due to a tree not being a true wayside tree, rather than that the key is at fault.

Part 3 includes the families arranged in alphabetical order. Under each family is a key to the genera, and under each genus a key to the species. These keys are kept as simple as possible consistent with adequacy. The text is liberally sprinkled with line sketches by the author of those parts of the plant which aid identification. The text itself is no mere collection of botanical data, but more often gives the biological life of the plant, its phenology, its synecology, pollination, folk-lore, and so on. Part 4 is taken up with the indexes.

Vol. 2 consists entirely of 228 half-tone plates, the great majority of which are of outstanding merit. These consist of tree portraits and photographs of leaves and flowers or fruits, or both, and are a valuable aid in identification.

The weight of the two volumes is about 5½ lb., which certainly makes the work difficult to carry about. But presumably, in Malaya every potential buyer possesses a vehicle of some sort, so that perhaps this is not the drawback it would be, for example, in Great Britain.

Dr. Corner and the Government Press, Singapore, are to be congratulated on the production of a really useful book. One would like to know how the Press contrived to produce this well-bound, beautifully printed book of 772 pages and 228 half-tone plates at the extremely reasonable price of just under £3.

N. L. BOR

A TRUANT FROM THE PSYCHOANALYTICAL SCHOOL

The Psychology and Psychotherapy of Otto Rank An Historical and Comparative Introduction. By Dr. Fay B. Karpf. Pp. xii+129+3 plates. (New York: Philosophical Library, Inc., 1953.) 3 dollars.

THIS book is not only a description of Rank's contribution to psychology, but is also an attempt to place him on the same footing as Jung and Adler with regard to Freud. This is unfortunate, since he remained an adherent of the psychoanalytical school until the age of forty-two, and his early death at fifty-five gave him little time to produce enough original work upon which to base a solid reputation after he broke away. In fact, although the author denies it, Rank is an example of Brill's statement that "Reflecting on the works of the Freudian secessionists, I feel that none of them has contributed anything of real value to mental science since they separated themselves from the master". It is, of course, an exaggeration but has some basis of truth.

Rank was more interested in the cultural aspects of psychoanalysis, and this is reflected in his work—as shown in "The Artist", "The Myth of The Birth of The Hero", etc.—an innovation from the point of view of sociology but not of much use clinically. In fact, it is doubtful whether any of his psychotherapeutic devices are of any value. He claimed to abbreviate treatment by fixing a terminal date for it, but this has not been found successful, and his "Will Therapy" seems aimed at conscious rather than unconscious elements. Dr. Fay B. Karpf does not make the most of the very real contributions to theory which Rank did make and, in discussing the trauma of birth, becomes side-tracked in a discussion on "masculine inferiority" and "womb envy" instead of using it to show how far back analysis may be forced.

This book is not an easy one to read: it is prolix, verbose and often difficult to understand. Such sentences as this one (from p. 75) abound: "Unlike the will concept which Rank took over as an organizing concept from the fields of psychology and philosophy after he became sensitized to the therapeutic manifestations of will phenomena, he arrived at the relationship concept directly from his therapeutic observation and experience and his consequent attempt to reinterpret the psychoanalytic conception of transference in terms of mother-centred dependency". Anyone interested in Rank and willing to labour through the complicated prose will find this book of interest; but it will not be of value to the general reader of psychology. The paper and printing are excellent; there are a good bibliography and a seven-page index.

CLIFFORD ALLEN

Theory of Wing Sections

Including a Summary of Airfoil Data. By Ira H. Abbott and Albert E. von Doenhoff. (McGraw-Hill Publications in Aeronautical Science.) Pp. viii+693. (London: McGraw-Hill Publishing Co., Ltd., 1949.) 127*s*. 6*d*.

THIS is a systematic and comprehensive summary of a great mass of data relating to the properties of a large number of wing-sections designed by the NACA. The book really falls into two parts. The first three hundred pages give a rapid summary of aerodynamic theory, the main emphasis being on incompressible flow and on wings of infinite aspect ratio. There is an introductory account of the effects of viscosity and of the effects of compressibility at subsonic speeds. A valuable chapter is concerned with flaps, slots and other high-lift devices. The remaining four hundred pages present data relating to a large number of NACA aerofoils, in tabular and graphical form. First of all, the tables are given for the geometrical form of the aerofoils concerned, together with the velocity distribution over their surface; then there is the usual information on section lift coefficients and moment coefficients, and on section drag coefficients for various angles of attack. The graphs indicate the Reynolds number at which the observations were made, together with information about the roughness of the surface. All the information in the four appendixes which form the second half of the book relates to low-speed measurements, but some account of wing-section characteristics at subsonic speed is given in Chapter 9.

There is no doubt that this book will form a standard reference book for aeronautical engineers, as it contains within the covers of one volume a great mass of information which can only be found with difficulty elsewhere.

The Dynamical Character of Adsorption

By J. H. de Boer. Pp. xv+239. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 30*s*. net.

THE time is passing when it is practicable to bring all aspects of sorption, chemical and physical, into the compass of one or two volumes. Rather the future may bring monographs dealing with special fields. This tendency has already shown itself, for example, in the monograph by the late J. K. Roberts, or in various chapters in the several volumes of "Advances in Catalysis". "The Dynamical Character of Adsorption" continues this tendency, in that it deals in particular with kinetic aspects: evaporation and condensation; surface migration; and possible two-dimensional equations of state and their significance in isotherm formulations. The author writes very clearly and in an interesting manner on monolayer sorption, throughout emphasizing molecular mechanisms and their consequences. As an example, one may refer to Dr. de Boer's demonstration that the five isotherm types in the classification of Brunauer may be obtained without considering anything other than monolayer sorption. As a rule, some of these isotherm types are considered to demonstrate multilayer formation. This result emphasizes that experimental data must increasingly be subjected to analysis in terms of free energy, heat and entropy of sorption as well as in other ways. Dr. de Boer says less on the subjects of multilayer sorption and capillary condensation than he does on monolayer sorption. The book has little to say on the detailed thermodynamics or statistical mechanics of adsorption, nor does it deal with various attempts to treat the complexities of multilayer sorption by modifications of potential theory. The treatment is nevertheless mainly from the point of view of theory, and the exposition is lucid and interesting. One may without reservation recommend Dr. de Boer's book to physical chemists whose special field is surface chemistry, while at the same time one feels it should attract the attention of other chemists as a direct, systematic and not too complex application of the kinetic theory to surfaces. R. M. Barrer

The Physical Chemistry of Surface Films

By Prof. William D. Harkins. Pp. xvi+413. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1952.) 80*s*. net.

THIS volume is almost exclusively a record of the contributions made to the subject by the author. Of the five chapters by Harkins, three have been expanded from articles which he had previously published in Jerome Alexander's "Colloid Chemistry"; but it is made clear in the introduction that but for the availability of these articles it is unlikely that Harkins could have completed the present book before his death in March 1951.

While the book provides an impressive picture of the many and varied contributions which Harkins made to our knowledge of the behaviour of surface films and deals in an interesting way with both the theoretical and practical aspects of the subject, it is often slightly misleading in that credit is not always given to other workers in the same field. Similarly, a list of some two hundred and seventy publications by Harkins includes roughly one-quarter of that number of papers on subjects other than surface chemistry. This, of course, serves to emphasize the breadth of Harkins's interests; but in the opinion of the reviewer it is a little unfortunate that contributions to other fields, such as nuclear chemistry, are not listed separately or omitted from a book bearing the title "Surface Films".

In spite of these comments, this is a stimulating record and should prove of interest to the worker on problems in surface chemistry. James Bell

Finding Nests

By Bruce Campbell. Pp. 256+24 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1953.) 12*s*. 6*d*. net.

WITH not only his own notes but those of his father and of the late Arthur Whitaker to draw upon, Bruce Campbell has compiled an excellent book on the breeding habits of British birds, with special reference to discovering their nests. The novice will here find a goodly store of information that should be helpful to him in his field-work, and, what is more, information of complete reliability, whether it concerns the willow warbler in some bushy habitat of the English Midlands or the whimbrel on a Shetland moor. The birds are dealt with species by species, concise remarks being made under the headings of "Distribution", "Season", "Habitat", "Nesting Site", "Nest", "Eggs" and "Methods". The paragraph on "Methods" deals with methods of finding the nest, all based on experience. This volume should make an ideal present for a bird-minded boy, sending him bird-nesting not with intent to take eggs but to try to increase our store of ornithological knowledge.

Frances Pitt

THE FOURTEENTH INTERNATIONAL CONGRESS OF ZOOLOGY

THE fourteenth International Congress of Zoology, held in Copenhagen during August 5–12, was attended by some eight hundred delegates, members and associates from forty-eight countries, ranging from Argentina and Australia to Finland and U.S.S.R., from Japan and Hawaii to Canada and the United States; 104 attended from countries of the British Commonwealth. The Congress, under the patronage of His Majesty King Frederik IX of Denmark, enjoyed the hospitality of the University of Copenhagen, in the halls and lecture rooms of which the numerous meetings took place.

At the opening meeting in the Festival Hall of the University the Congress was addressed by the Minister of Finance, Dr. Thorkil Kristensen, who welcomed the members to Copenhagen on behalf of His Majesty; by the secretary-general of the Permanent Committee of the International Congresses of Zoology, Prof. Louis Fage; and by the president of the Congress and of the Danish Organizing Committee, Prof. R. Sparck. Prof. J. Z. Young then delivered his lecture on "Some Thoughts on Zoological Communication" in which he outlined his views on some aspects of the philosophy of zoology. The afternoon and evening were occupied by a visit to Elsinore and a reception by the Lord Mayor and Corporation of the City of Copenhagen at the Town Hall. The greater part of the following six days was taken up by the meetings of the sixteen sections, and of the International Union of Biological Sciences colloquium on the distribution and origin of the deep-sea bottom fauna, at which more than 250 communications were discussed; there were in addition four general meetings.

A colloquium called by the International Committee on Zoological Nomenclature had been in daily session for the week preceding the Congress; it had discussed a great number of nomenclatorial problems, and prepared resolutions for consideration by the Section of the Congress dealing with Nomenclature. These were discussed further by the Section, and the report and recommendations of the International Committee were presented to the final general session of the Congress, at which they were formally adopted. A survey of these proceedings follows this article.

It was appropriate that a large number of the communications laid before a Congress meeting in a country of such ancient maritime associations as Denmark should deal with various aspects of marine biology. A high proportion of papers in nearly all the sections was, as would be expected, based upon experimental work; and although no spectacular new discoveries were reported, the general quality of the communications was high, and the ensuing discussions were lively and instructive. It is impossible to mention even the titles of all the many papers presented, and the following remarks report only some items that particularly interested one delegate.

Prof. Emil Witschi (Iowa) proposed to conclude an agreement among vertebrate embryologists concerning some basic principles that should guide the standardization of numerical systems of embryological stages. This could be accomplished by ascribing to the nine great sections or periods of development a varying number of numeral standard stages. He suggested the following system: I, Cleavage (1–6); II, Blastula (7); III, Gastrula (8–11); IV, Primitive Streak (12); V, Neurula (13–16); VI, Tail Bud (17–24); VII, Embryo (25); VIII, Metamorphosis (26–34); IX, Fœtus (35–36). Special investigators will differ in their needs for subdivision of periods, and the desire for greater specialization should be met by letter suffixes. The stages are based mostly on features of external morphology, and preference is given to embryonic over extra-embryonic characters, to axial over lateral organs, and to cranial over caudal conditions of differentiation. The terminally additive nature of evolution within the vertebrates is expressed by the conclusion of embryonic development at progressive stages: 25 in fishes, 30–32 in urodeles, 34 in anurans and 36 in birds and mammals.

Chr. Vibe (Copenhagen), in discussing the zoogeography of Greenland, pointed out that a study of the land fauna shows more and more clearly that it is the remnants of an old fauna which had a more or less circumpolar distribution before the glacial period, but which later on became confined to isolated localities distributed over the boreal and arctic area. The fauna has been able to exist during the glacial period and after because the straits on each side must have been more or less closed, restricting the polar currents, so that the Gulf Stream influenced the climate much more than it does at present.

In a study of the ethology of the roe deer, F. W. Braestrup (Copenhagen) concluded that the social organization of the species, which is much less developed in the red deer, is not due to the organization being patriarchal as claimed by Fraser Darling. Roe deer are not patriarchal, and the reason for the looser social structure is merely that roe deer are mostly inhabitants of thick bush.

C. B. Philip, J. F. Bell and C. L. Larson (Hamilton, U.S.A.) reported observations on peak populations of jack rabbits (*Lepus californicus deserticola*) in Nevada, and on evidence of exposure to infection or parasitic infestations which might influence population trends. Sick and recently dead animals were observed; but no major cause for decimation was discovered, nor has any recent 'crash' in population numbers occurred. Serological evidence showed exposure to Western equine encephalomyelitis, rickettsial spotted fever, brucellosis, and, to a much smaller degree, tularæmia. It is not evident that any of these diseases will be involved in the expected general die-off in the whole area. Hewitt's opinion that the cause of the sudden plague which kills off the rabbits at their greatest abundance is probably of a multiple nature may well prove to be correct.

Prof. A. Vandel (Toulouse) gave an account of the recently established "Laboratoire souterrain" at Moulis (Ariège). Part of the laboratory is actually within the cavern of the Grotto de Moulis, and is fully equipped for biological and physiological research. On the surface another building provides further laboratories, library and living accommodation for workers on all aspects of speleology including *biospélélogie*.

Prof. P. Drach (Paris) described his investigations on the coral reefs of the Red Sea, which he explored by means of a self-contained diving apparatus that allowed depths of 50–70 m. to be reached. The reefs

of the Far-San Archipelago are superficially very diverse, but are all remarkable for the extreme steepness of their sides, which descend in a series of almost vertical cliffs separated by narrow platforms. The distribution of organisms on the reefs is dependent upon the turbulence of the water, the intensity of illumination, the depth, and the slope of the sides. The physical conformation of the reefs, and the existence of a submarine cliff 650 m. high, fit Darwin's theory of the formation of coral reefs by subsidence.

In his paper on marine bottom substrata and their fauna, Prof. C. M. Yonge (Glasgow) showed that the major factors influencing the distribution of bottom invertebrates are food and the nature of the substratum. The main problem is the potential food value of the deposits, for detritus contains a hundred times more organic carbon than is contained in the total fauna and flora. Knowledge is urgently required about the nutritive value of detritus, and about the factors controlling its local concentration. Bottom associations cannot be regarded as consisting of interdependant organisms as are the members of associations on land. The carnivores depend upon the presence of the suspension- and deposit-feeders; but members of these are all competing for the same food and so would actually benefit if competitors were absent. In this connexion the paper by Prof. C. ZoBell (La Jolla, California) was of great interest; in it he discussed the occurrence of bacteria in the deep sea and their significance to animal life. It appears probable that they provide the first step in the chain of organic food substances at great depths.

But the communication of greatest general interest on marine biology was the lecture, illustrated by a colour film, given by Dr. Anton Bruun (Copenhagen) on the methods and results of the *Galathea* Expedition, 1950–52. The film showed all phases of the voyage, the object of which was to explore the greatest ocean depths, and it was a remarkable experience for most of the zoologists present to see close-up moving pictures of the extraordinary fishes and invertebrates as they were brought on deck from immense depths fresh and in their natural colours, and in many cases still alive. Many of the more striking specimens collected on the voyage were on exhibition in the University Museum, and the vessel herself was lying in the harbour.

A communication from Prof. C. Hubbs (La Jolla, California) gave news of one of the most interesting of the larger Cetacea, the Pacific grey whale, which had been very nearly exterminated by the early years of this century. It has lately made a great recovery in numbers, and as its migration route passes close inshore off La Jolla, the zoologists of the Scripps Institute have been able to make close observations on its numbers. The observations from land have been supplemented by surveys made over the sea and the lagoons of Lower California from a helicopter, and it has been ascertained that a population of many hundreds of the animals frequents these waters. The paper was illustrated by remarkable photographs of the whales taken at close range from the helicopter.

Other aspects of marine biology were discussed, among many others, in papers by G. P. Wells (London) on "Inherent Rhythms in the Behaviour of Worms", D. L. Ray (Washington) on the "Digestion of Wood by *Limnia lignorum*", and Prof. P.-H. Fischer (Vietnam) on "Gasteropodes Excavateurs de Roches littorales".

These communications are, however, no more than a random sample from the immense variety presented to this most interesting and stimulating Congress—a variety ranging from "Paper Chromatographic Analysis of Taxonomic Relationships in *Drosophila*", "Polarized Light and Arthropod Vision", and the "Perception of Low-frequency Vibrations by *Semotilus atromaculatus*", to the "Display, Breeding Cycles and Phylogeny of Bower Birds", the "Influence of Spermatic Hormones on Spawning and Water Flow in the Oyster", and "Wirkungen der Epiphysectomie und der Epiphysolbehandlung bei Fischen".

The Danes are the most hospitable of hosts, and in addition to the scientific sessions they had prepared a very full programme of excursions, receptions, dances and other social functions that were greatly enjoyed and appreciated by the members of the Congress—at the closing banquet a footnote on the menu, in which all the main ingredients of the dishes were given their scientific names, warned "*Hae nomina sunt conservanda in spiritu vini*", an echo of the deliberations of the International Committee on Nomenclature.

At the closing General Session of the Congress an invitation conveyed by Dr. E. Hindle from the Royal Society of London to hold the fifteenth International Congress of Zoology in London in 1958 was received with acclamation, and Dr. G. R. de Beer, director of the British Museum (Natural History), was elected to be its president. British zoologists will hope that the Government will place funds at the disposal of the organizers of the fifteenth Congress on a scale similar to the support afforded by the Danish Government to the fourteenth. L. Harrison Matthews

ZOOLOGICAL NOMENCLATURE

AMENDMENTS TO THE INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE

THE fourteenth International Congress of Zoology, Copenhagen, August 1953, carried through the second stage of the important and long overdue process of overhauling the International Code of Zoological Nomenclature, of which the first stage took place at the thirteenth congress held in Paris in 1948. The work on zoological nomenclature at Copenhagen was path-breaking as regards both procedure and achievements, because the procedure was new and without it the achievement would not have been possible.

The procedure differed from that at any previous Congress in two essential respects: first, very elaborate measures were taken to provide the Congress in advance of its meeting with an ample documentation on all the nomenclatorial problems to be considered; second, arrangements were made for the careful consideration and full discussion of this material at a colloquium on zoological nomenclature which sat daily at Copenhagen for a week prior to the opening of the Congress. The preparations for this meeting consisted in the publication by the International Trust for Zoological Nomenclature early in 1952 of a special volume (vol. 7) of the *Bulletin of Zoological Nomenclature* containing a discussion of the major problems of zoological nomenclature which had been remitted by the Paris Congress for further study and for consideration five years later at Copenhagen. This volume was communicated by the Trust to museum nomenclature committees and leading zoological and palæontological institutions and served to secure for the Copenhagen

Congress a large and representative range of comment on the difficult problems involved. Later—in 1953—these comments, together with the documentation relating to other items on the Copenhagen agenda, were published by the Trust in two special volumes (vols. 8 and 10) of the *Bulletin*. In March of this year the Trust issued invitations both to institutions and organizations concerned with systematic zoology (including palæozoology) to appoint representatives to the colloquium. In addition, personal invitations were issued to the members of the International Commission on Zoological Nomenclature and to other specialists known to be interested in nomenclature. When the colloquium opened on July 29, it numbered more than fifty members drawn in almost equal numbers from the Old World and the New. Sixteen meetings were held by the colloquium before the opening of the Congress, and the full and detailed discussions held made it possible to reach agreement upon recommendations to be submitted on all except one of the seventy items on the agenda. Some of the problems involved were of great complexity and might well have led to sharp disagreement, if it had not been for the general desire of all the members of the colloquium to achieve solutions which were both the best obtainable in the circumstances and in addition commanded the general support of interested zoologists.

A further important and novel feature of the procedure adopted at Copenhagen was the clear recognition for the first time of the essential difference between the advisory functions of the International Commission on Zoological Nomenclature in the legislative field and the strictly judicial functions of that body. At Copenhagen—unlike at previous congresses—there was no discussion of individual cases, which it was recognized could be dealt with better by the Commission by means of postal votes. The whole of the time available was thus devoted by the Commission, the Colloquium and the Section on Nomenclature of the Congress to the reform of the code. This procedure possesses the great merit that it recognizes that it is vital that reforms of the code should command the widest possible support of zoologists generally and that, to secure this end, extensive and representative consultations, followed by full discussion, are essential. The practical value of this procedure is attested by the fact that it made it possible to submit to the Congress a comprehensive report on the whole range of problems considered.

The first and most important single subject dealt with was how to provide means for ensuring that zoological nomenclature shall be both stable and universally accepted. The attainment of this object was sought by a number of means: (*a*) the addition to the code of a preamble stressing that the foregoing were the objects for which it had been established; (*b*) the introduction of machinery for the disposal of the threat to stability represented by dormant *nomina dubia*; (*c*) the recognition (by a majority vote) of the principle of conservation under which, subject to certain safeguards, a junior synonym which has been in general use for a considerable period will be protected from being replaced by a senior synonym which is virtually unknown and has scarcely ever been used; (*d*) the addition of provisions for restricting and designating type localities for nominal species where those given by the original author were either too vague or incorrect. The second addition to the code of great importance was the introduction of provisions for the recognition, subject to strict safeguards, of neotypes as a category of type specimen in cases where the original type material is lost and definite identification is impossible without detailed examination of the structure of a specimen serving as a unique standard of reference.

Next, the Congress introduced a comprehensive series of rules for the naming of taxa belonging to the family-group of categories in place of the wholly inadequate provisions (Articles 4 and 5) in the present code. At the same time, the Congress introduced provisions for regulating the naming of orders, classes and phyla, the one field in which hitherto the code had possessed no provisions and in which the utmost instability and confusion prevails. Under these provisions, names belonging to these groups, like names for all lower categories, will be defined by the type method. The selection of names for units already established in these categories will be made by committees of specialists in the groups concerned, and an opportunity for comments by specialists will be provided before the names recommended by the committees are finally approved by the International Commission and placed on the "Official Lists" established for this purpose by the Congress. Next, the Congress completely overhauled the provisions (Article 19) relating to the emendation of names, wiping away the ambiguities which in the past have led to much confusion and greatly reducing the area within which emendations will be permissible, niceties of etymology and the like no longer constituting a valid ground for emending a name.

Having thus disposed of the major problems referred to it by the Paris (1948) Congress, the Copenhagen Congress dealt also with the large mass of problems which have been brought forward since the Paris Congress. Of these, the following call for special mention: (1) the withdrawal, subject to safeguards in the interests of current practice, of recognition from names first published in synonymies; (2) the introduction of words designed to ensure that for a specific name published subsequent to December 31, 1930, to acquire availability its author must have attempted to indicate the characters relied upon by him as diagnostic for the unit named; (3) the banning of the distribution of microfilms, microcards and the like as a method of 'publishing' zoological names; (4) the reversal of the Paris decision to substitute the page precedence principle for that of the First Reviser for determining the relative precedence to be assigned to names published in the same book and on the same date; (5) the introduction of provisions to prevent the wanton invalidation of specific names as junior secondary homonyms by unions of genera regarded as unjustified taxonomically by specialists in the groups concerned.

Many of the provisions introduced at Copenhagen are marked by a provision of a novel character designed to enable systematists, wherever possible, to take advantage of the means afforded for ensuring stability without having to submit every case individually to the International Commission. By this method, specialists are required to act on the provisions in question immediately upon the appearance in the *Bulletin of Zoological Nomenclature* of a notification of the publication by an author of a paper in which he has taken advantage of the provision concerned. Within specified periods, such action is open to challenge and, if so challenged, the case is to be referred to the Commission for decision. In other cases, the action taken becomes definitive at the end of the prescribed period and the name

concerned is placed on the appropriate "Official List" of valid names or on the appropriate "Official Index" of rejected names. This procedure, while of great convenience to systematists, inevitably throws a greatly increased burden of work upon the secretariat of the International Commission and, through the increase in the amount of material to be published in the *Bulletin of Zoological Nomenclature*, will increase still further the financial difficulties of the International Trust for Zoological Nomenclature, the incorporated body which conducts the business affairs of the (unincorporated) International Commission. So serious, indeed, are the difficulties of the Trust—which possesses no income other than that obtainable from the sale of its publications—that the Right Hon. Walter Elliot, chairman of the Trust, paid a special visit to Copenhagen for the express purpose of warning the zoologists and palæontologists there assembled—and, through them, the great scientific institutions in which they work—that it would be impossible for the Trust to continue to maintain the work of the Commission unless a scheme were to be devised for providing the annual income essential for this purpose.

During the Congress, the colloquium drew up a report setting out in detail the recommendations for the reform of the code which it had adopted in the week preceding the opening of the Congress, and this report was discussed in draft both with the International Commission on Zoological Nomenclature and with the Section on Nomenclature of the Congress. As the result of these discussions, the report of the colloquium was submitted jointly by both these bodies to the Copenhagen Congress, by which it was unanimously adopted at the final *Concilium Plenum*. The report of the colloquium accordingly constitutes the official record of the decisions on nomenclature taken by the Copenhagen Congress, and, as such, will be an indispensable work of reference to all systematists until such time as it is possible, on the basis of the Paris (1948) and Copenhagen (1953) decisions, to prepare and promulgate a revised text of the code. In agreement with the Congress and at its request, the International Trust for Zoological Nomenclature is publishing the report of the colloquium in book form. In order to bring this work within the reach of every zoologist, the Trust is subsidizing this publication to an extent sufficient to enable it to be placed on sale for five shillings (75 U.S. cents); copies will be obtainable from the offices of the Trust (41 Queen's Gate, London, S.W.7). It is expected that publication will take place towards the end of November. Francis Hemming

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

OPEN DAYS

THE annual open days of the Chemical Research Laboratory, Teddington, were held this year during September 22–25. A feature of the previous year was the new building provided for radiochemical work, and this year another new laboratory was open for inspection. This was a building of prefabricated type but specially fitted for microbiological research. It has a floor space of about 3,000 sq. ft. and contains five research rooms, an instrument room, a small library, a general fermentation laboratory with cold and warm chambers, and a 'kitchen' for the preparation and sterilization of media and glassware. The design is such that the risk of contamination of cultures is brought to a minimum. The air is filtered before entry, sliding doors are provided to prevent draughts, and the walls and floors are finished to allow easy cleaning. This building was occupied during November 1952.

The main topic of the Microbiology Group is the fundamental study of the metabolism of sulphate-reducing bacteria. Interesting exhibits related to the counting of these bacteria, and a demonstration was given of the presence of cytochromes detected for the first time in anaerobic bacteria. The production of sulphide and methane by anaerobic digestion of sewage sludge supplemented with sulphate was demonstrated. Another exhibit illustrated the breakdown of aromatic compounds by bacteria isolated from filter beds in which effluents from chemical works are rendered innocuous. An important section of the Group is the National Collection of Industrial Bacteria. The primary purpose of the Collection is to supply on request cultures of bacteria required by industry and research establishments, and some seven hundred cultures were sent out during 1952 to organizations all over the world. The Collection now maintains nearly six hundred strains of bacteria, as well as several antibiotic-producing organisms deposited by the United Nations World Health Organization. Research is being carried out on the effect of freeze-drying on the biochemical characteristics and viability of the cultures.

Earlier work of the Laboratory's Inorganic Group revealed that certain flue dusts provide a concentrated source of germanium and gallium, and the dusts are now being used commercially for the production of these elements. A new extension of the work on the recovery of valuable products from wastes or low-grade materials is a search for selenium in dusts and sludges arising in the purification of the sulphur dioxide produced by the burning of pyrites in the new flash-roaster plants. In most of the dusts the selenium content is small, ranging from 10 to 100 parts per million; but in one type of sludge the amount rises to 1–2 per cent, while in another type, three samples of which were shown during the open days, the content varies from 7 to 21 per cent on a dry basis. If these sludges occur in sufficient quantity, they may prove to be a useful source of this increasingly important element. In addition to pure germanium and gallium prepared in the laboratory, samples of twenty other metals in a high state of purity were exhibited, the most striking of these being titanium prepared by the van Arkel process. These metals form part of the stock held by the Pure Metals Committee of the Department of Scientific and Industrial Research.

The Inorganic Group is also responsible for microchemical and spectrographic analyses required either by the Laboratory or other stations of the Department. The sections concerned are well equipped with modern apparatus, and the expert teams are prepared to give advice on the applications of these instruments.

The exhibits in the Radiochemical Group were largely concerned with separation techniques for metals and acid radicals, with particular emphasis on chromatography and ion exchange. Of special interest in chromatography is the development of this process to geochemical prospecting by a simple and rapid method for use in the field. Extracts of the mineral samples under study are obtained usually by simple

acid treatment. Portions of the solutions so obtained are then applied to the bottom of a rectangular sheet of adsorbent paper on which a series of vertical slots are cut to form separated strips joined at the top and bottom. The sheet of paper is then rolled into a cylinder and placed upright in a beaker containing a small quantity of solvent and upward diffusion allowed to proceed for 10–15 min. The sheet is then removed, dried and sprayed with test solution when coloured bands of the metals become visible. Comparison with standard stains provides a rough quantitative measure of the metal in the sample. This method has proved successful with copper, cobalt, tin, zinc, uranium, lead, gold and niobium.

Several exhibits demonstrated the application of ion-exchange resins to metal separation, and in two of these experiments, dealing respectively with recovery of gold from cyanide solution and separation of copper and nickel, organic solvents were used for elution of metal from the resin. Equipment shown in this building included apparatus for radioactive measurement, automatic testing of the behaviour of ion-exchange resins on repeated treatment with solutions, continuous recording of concentration of metal in solution by a polarographic technique, and fluorimetric determination of uranium. Apparatus and methods for concentration of metals from minerals and ores were also exhibited.

The work of the Corrosion of Metals Group is concerned with the study of corrosion and its prevention in aqueous solutions, in underground conditions and in the atmosphere. In these researches methods of reproducing the effects of prolonged exposure in a short time are required, and many of the exhibits related to such accelerated tests. These included high- and low-speed rotors, a standardized atmospheric test of a simple type, and a totally enclosed 'weatherometer' in which cycles of spray, light and heat could be applied automatically in predetermined proportions. To the same category belongs the study of the corrosion of boiler tubes. Here the effort is directed to the introduction of conditions so that rapid corrosion occurs, reproducing the effect of prolonged use in service conditions. Once this accelerated test is established, it will be used for the study of inhibitive measures. Apparatus assembled for the corrosion of steels by hot flue gases was exhibited.

Much progress has been made in studies of the inhibition of sulphate-reducing bacteria. Examples of well-preserved iron articles, found in the site of an ancient tannery, led to the discovery of the inhibitive action of tannin and tannic acid; certain metallic salts are also effective, and from some non-aggressive soils a species of *Actinomyces* has been isolated which produces a thermolabile substance that also inhibits the bacteria. Elementary sulphur is often found in the products of bacterial corrosion. It has been found that aqueous suspensions of sulphur exert a rapid attack on steel comparable with that of dilute acid, and it is possible that sulphur may play a more important part in underground corrosion than was hitherto suspected. The specific action of sulphur on iron and steel has been applied to the examination of the completeness of other metallic films on ferrous metal surfaces; it has also been applied to the etching of steel, and several striking examples of this were exhibited.

Other subjects illustrated by exhibits included the removal of films from metal surfaces and their examination by the electron diffraction camera, the study of inhibitive action by radiometric tracer technique, the use of electrical measurements in studying paints on steel in sea water, and the application of inhibitors in temporary protectives and in packaging.

The purification of industrially important organic compounds to the highest attainable standard ($\sim$ 99·9 mol. per cent) and the measurement of the physico-chemical properties of such materials has been a leading theme in the work of the Organic Group for some years. For its effective prosecution this project requires specialized techniques and methods which are outside the scope of many industrial or academic laboratories. Nevertheless, the results which flow from this class of work have wide interest: on one hand, accurate and trustworthy data (melting points, boiling points, densities, refractive indices, solubilities, heats of combustion and ultra-violet and infra-red absorption spectra) are accumulated which are of theoretical and practical use; on the other, standard reference samples can be made available to outside workers needing them for calibration or analytical purposes. Several hundreds of such standards have already been distributed. Many of the exhibits exemplified the techniques which have been applied in various parts of this work. Thus, several kinds of very effective fractional distillation columns were shown, including an example of the spinning-band type. Fractional crystallization at temperatures between $-$ 180° and $-$ 20° C. was also displayed in suitable apparatus. Spectroscopic methods are used, in conjunction with the plotting of freezing-point/time curves, for the estimation of residual impurities, and this crucially important side of the work was fully illustrated by assemblages of equipment, much of which, including a mass spectrometer, has been constructed at the Laboratory. Other apparatus displayed was used in accurate measurements of boiling point, heat of combustion, liquid–vapour equilibria and solubility in water.

In a different field of organic work the Intermediates Section of the Organic Group has applied its chief effort to the preparation of new potentially useful materials by carboxylation procedures and to the preparation of new ion-exchange resins containing phosphonic or arsonic acid groups. Work on the applications of isotopically labelled compounds has also been continued. Many exhibits indicated the extent of success which has attended these lines of work during the past year.

In the High Polymer Group work on semi-permeable membranes, the determination of molecular weight, and ion exchange was shown. A new laboratory maintained at constant temperature has been built which is now being used for osmometry and other physico-chemical measurements, and apparatus on show in this laboratory included precision thermostat baths, a light-scattering photometer, interference refractometer and allied equipment. A range of membranes of graded permeability and suited for use in non-aqueous systems has been produced from polyvinyl alcohol. Using membranes of an appropriate permeability, the molecular weights of simple compounds of known structure may be determined by osmometry. Thus details were shown of the determination of the molecular weights of tristearin, pentaiodobenzene and sucrose octaacetate.

A new type of ion-exchange resin containing chelating groups was exhibited. Resins of this type

are of considerable potential importance in certain industrial applications of ion exchange. One exhibit showed a chelating resin being used for reducing the copper content of tap water from 1 p.p.m. to less than 0·05 p.p.m. Other ion-exchange materials shown included a range of resins containing ion-exchange groups at the surface only.

RUMINANT DIGESTION

A DISCUSSION on "Ruminant Digestion" took place on September 8 at a joint session of Section I (Physiology) and Section M (Agriculture) of the British Association, during its meeting in Liverpool.

The opening speaker, Mr. A. G. Singleton (University of Liverpool), discussed the significance of the rate of passage of food through the ruminant stomach, and some of the factors controlling it. The efficiency of the ruminant as a cellulose digester depends mainly on the delaying power of the rumen, which determines the time available for cellulose digestion to occur. If the contents of the four stomach compartments are examined in an animal killed soon after feeding, the rumen and reticulum are found to contain pieces of hay or other food of a relatively large size, the omasum always contains very finely divided particles in a relatively dry state, and the abomasum contains particles of about the same size suspended in a more fluid medium. It seems either that particles do not leave the rumen and reticulum until they have attained a certain smallness of size, or that the omasum reduces their size by a grinding action. Rumination and bacterial action tend to reduce particle size in the rumen. There is little evidence of any triturating activity of the omasum; the dryness of its contents could be due to a squeezing action, but it seems more likely that it is produced by water absorption. There is some evidence that the reticulo-omasal orifice has a valve-like action, and the omasum may control the flow of contents from the reticulum to the abomasum.

The feeding of hay or of straw which has been chopped or ground reduces its digestibility, a fact which was assumed to be due to an increase in the rate of passage of the feed. Balch (1950)[1], however, found that when ground hay was fed with normal hay it passed through the rumen more rapidly; but when the whole ration was ground, it remained in the rumen for an abnormally long period, and fibre was less completely digested. The reason for this is unknown, but the shorter time spent in ruminating, which is known to occur when the ration is ground, may be a contributing factor. This would reduce the amount of salivation, and it is known that an increase in the dry-matter/water ratio reduces the rate of cellulose breakdown.

It has been shown that the composition of duodenal contents influences the motility of rumen, reticulum and abomasum. Acid, protein and fat introduced into the duodenum inhibit the movements of these three compartments. Distension of the duodenum and abomasum also inhibits the movements of other compartments. It appears that chemical and physical factors may exert an important influence on the emptying of the stomach, in addition to the factor of particle size.

Mr. Singleton then described an electromagnetic method which is being used for continuously recording flow through the duodenum, and with which the factors affecting the emptying of the stomach are being investigated.

Dr. R. S. Comline (University of Cambridge) spoke on the nervous control of the ruminant stomachs. A strip of reticulum, attached to its blood and nerve supply, contracts in response to stimulation of vagus, right splanchnic nerve (with the right adrenal removed), left thoracic sympathetic chain, and the intravenous injection of adrenaline. The vagal effects are stronger than the sympathetic and are abolished by atropine. The sympathetic effects are unaffected by atropine, but are prevented by sympatholytic drugs, such as 933 *F.*, and by vagal stimulation. In chronic experiments, ruminants are unable to survive double vagotomy, which abolishes the normal propulsive motility, whereas the sectioning of both splanchnic nerves is without obvious effect.

In decerebrate calves and lambs, the œsophageal groove closes in response to water flowing over the pharynx, or to stimulation of the cut superior laryngeal nerve, which could also produce reflex swallowing. The reflexes of groove-closure and swallowing are closely integrated, but the two responses are affected differently by different stimuli. Reflex groove contractions can be inhibited by stimulation of the abomasal branch of the vagus. In decerebrate adult animals, reflex contractions of the reticulum could be invoked by stimulating the central ends of the abomasal, reticulo-omasal and reticular branches of the ventral vagus. Stimulation of the hypothalamus can produce movements in the alimentary canal, and even rumination.

Dr. Comline then criticized the tendency to call a particular part of the ruminant stomach a pace-maker. The stomach movements are not myogenic, as are those of the heart; they disappear when all extrinsic nerves are cut. A more profitable analogy, he said, is with the control of respiration, where a central rhythm is modified by afferent stimuli.

Dr. A. T. Philipson (Rowett Research Institute) contributed a paper on absorption from the rumen of the sheep. The rumen, reticulum and omasum are lined by stratified squamous epithelium, but the layer of keratinized cells is much thinner than in skin. The finding that the concentration of short-chain fatty acids is about 7–10 times greater in the rumen than in the abomasum suggests that absorption takes place, and this has been proved by showing the presence of fatty acids in significant concentrations in the blood leaving the rumen. Many investigations have been made on the rates of absorption of short-chain fatty acids, and it is agreed that absorption is more rapid when the *p*H is acidic than when it is neutral or just over *p*H 7, and that an acidic *p*H has a greater effect with propionic than acetic acid, and with *n*-butyric than propionic acid.

A comparison of the fatty acids in the rumen with those in blood leaving the rumen does not agree with these findings. It is found that the proportions of fatty acids in blood and rumen are similar, except that less butyric acid is present in blood. This led to an investigation of the metabolism of these acids by the rumen wall, which showed that considerable losses of butyrate occur, while losses of acetate are small. Metabolism of propionate is increased by the presence of carbon dioxide. The discrepancy is explained by the fact that about half the butyrate absorbed enters the blood stream, the rest being metabolized, while a little less than one-third of the propionate disappears. The acetate losses are likely

to be less than 5 per cent of the total. It is probable that the rates of absorption of these acids are related to their metabolism by the epithelium, but the evidence is meagre. Fluoroacetate inhibits their absorption, but not differentially; monoiodoacetate has no effect on the rates of absorption. Phosphorylating mechanisms, therefore, do not seem to be concerned.

With acetate it is possible to study absorption from very weak solutions, as it is not metabolized to any great extent. It is found that absorption is proportionally more efficient for lower than for higher concentrations. A possible explanation is that a mechanism exists for transporting acetate across the epithelium, but as the concentration in rumen rises the mechanism becomes saturated and any further transport is by the slower process of physical diffusion.

Pennington has shown that rumen epithelium *in vitro* can form ketone bodies from butyrate. The oxygen consumption of the epithelium is considerable, even when no fatty acids are present in the medium. Glucose and butyrate increase oxygen consumption, but acetate does not. Propionate increases oxygen consumption only when carbon dioxide is present. Fixation of carbon dioxide occurs during the metabolism of propionate, and at least part of the propionate disappears via the tricarboxylic cycle, for succinate, an intermediary, increases when the cycle is arrested by the presence of malonate. The epithelium shares the unusual ability to form ketone bodies with liver and kidney. Another product of microbial activity is ammonia, and this is absorbed in substantial quantities, 0·3–0·4 gm. ammonia–nitrogen/hr. from concentrations of 50 mgm. ammonia–nitrogen/100 ml.

The removal of end-products is necessary if a reasonably constant environment is to be maintained for the bacteria, and in this respect hydrogen-ion concentration is important. Saliva provides a buffer; but the permeability of the rumen to ions in solution is also important. Any solution in the rumen tends to change to a *p*H of 7·2–7·4, whether acid or alkaline originally, and this is due to a differential passage of ions across the epithelium in both directions. When fatty-acid anions are absorbed, a proportionate amount of bicarbonate enters the rumen. In the rumen liquor of normal sheep potassium and inorganic phosphorus are in a much higher concentration than in plasma; magnesium and calcium are also in excess, while sodium and chloride are lower, so that concentration gradients are not the only factors involved.

Phosphorus apparently penetrates the epithelium only in minute quantities, while potassium is readily absorbed from rumen liquor or aqueous solutions. Sodium and chloride can traverse the epithelium in both directions, even against a concentration gradient. Water can pass across the epithelium in quantity: hypotonic solutions placed in the empty rumen lose water, and hypertonic solutions gain water. The quantities absorbed do not increase directly with an increase in molarity, which suggests that there is a maximum rate of water flow under these conditions. The omasum is permeable to water, and it is known to concentrate phosphorus, magnesium, calcium and chloride, either by water absorption or the passage of ions across its epithelium.

The last speaker was Mr. R. J. Garner (University of Bristol), who discussed the intermediary metabolism of ruminants. Most of the carbohydrate digested is absorbed as short-chain fatty acids, all available evidence indicating that very little glucose is absorbed from any part of the alimentary tract. Of these fatty acids, propionic is the only one known to be glycogenic; it is rapidly converted into glucose in the liver, and very little enters the peripheral circulation. Acetic acid is oxidized by many tissues in both ruminants and non-ruminants, and it is also utilized for fat synthesis. The high arterio-venous differences in acetic acid concentration in the sheep's head and the cow's mammary gland indicate that it is metabolized extremely rapidly by ruminant tissues. Butyric acid is usually considered to be ketogenic, yet intravenous injection of sodium butyrate has been stated to relieve hypoglycæmic symptoms in lambs and rabbits. However, it is known that butyric acid is selectively metabolized by rumen wall, largely to ketone bodies, so that only a small proportion of the butyrate produced enters the blood.

The adult ruminant depends on short-chain fatty acids for most of its energy, and shows striking changes in its behaviour towards glucose. One of the most remarkable features of the adult ruminant is its ability to tolerate extremely low blood-glucose levels. The erythrocyte of the ruminant is relatively impermeable to glucose, so that the level of glucose in whole blood approximates to plasma levels. Even when this fact is considered, the ruminant is in a permanent state of hypoglycæmia as compared with most other species. This low blood-sugar level is accompanied by a reduced ability of ruminant tissues to utilize glucose. When injected intravenously it is removed from the blood at a much lower rate than from the blood of man or dog. In this respect the ruminant resembles a diabetic man.

Young ruminants on a milk diet have a blood-sugar level and glucose tolerance similar to non-ruminants: the appearance of adult conditions coincides with the development of rumen function. It has been suggested that it is the onset of ruminal digestion which initiates the change in behaviour towards glucose, and there is some evidence that this change can be postponed by prolonged milk feeding, withholding roughage, or including antibiotics in the diet.

The rise in blood fatty acid which follows the onset of ruminal digestion coincides with a pronounced fall in blood-sugar level, which suggests that the increased intake of these acids may be a factor. However, horses and rabbits also absorb considerable quantities of fatty acids from the cæcum, and yet remain normal in blood-sugar level and glucose tolerance. Fermentation in the rumen also leads to a fall in the amount of carbohydrate absorbed. In the non-ruminant, a high-fat, low-carbohydrate diet causes a reduction in blood-sugar level, a reduced glucose tolerance and a reduced rate of absorption of glucose from the intestine (due to a lowered hexokinase activity), a change approximating to the normal state of affairs in the ruminant.

The effect of diet on intermediary metabolism is not understood. It has been suggested that certain products of metabolism, including acetate, act as cellular regulators, shifting the emphasis in metabolism from carbohydrate to fatty acid according to nutritional conditions. Rumenal fermentation may cause the change in carbohydrate metabolism simply by altering the proportions of carbohydrate and fatty acid available to the cell. Attempts to alter these proportions absorbed by the adult ruminant have led to no observable changes in carbohydrate metabolism. The low normal blood-sugar level of adult ruminants may be a result of a change in balance between the

pancreatic, anterior pituitary and adrenal hormones which regulate it. Dietary factors can affect the functional activity of the anterior pituitary and possibly of the adrenal cortex, and can also alter the sensitivity to insulin.

The foregoing evidence suggests that nutritional conditions are chiefly concerned in bringing about the observed peculiarities in intermediary metabolism and hormonal balance in ruminants. In conclusion, Mr. Garner suggested that the low blood-sugar level may be an adaptation of physiological importance in conserving carbohydrate for essential purposes.

A. G. Singleton

[1] Balch, C. C., *Brit. J. Nutrit.*, **4**, 361 (1951).

OBITUARIES

Mr. R. Burne, F.R.S.

By the death of Richard Burne, British zoology has lost far more than the maker of minutely perfect dissections and the writer of accurate and beautifully illustrated descriptions of animal structures, whose working life was spent among John Hunter's specimens in the Royal College of Surgeons. Burne was a shy, quiet man, who avoided publicity and, probably owing to a slight stammer, rarely read papers before scientific societies or delivered lectures to students. Few really knew him well, and still fewer were in a position to appreciate his outstanding abilities as a comparative anatomist. It was not until he was in his sixtieth year that he was elected a Fellow of the Royal Society.

Burne carried the art of self-effacement to almost extreme lengths. He was always ready to credit to others the work that, as a matter of fact, he had himself accomplished. He worked in Lincoln's Inn Fields just as William Clift, more than a century before him, had done: a man whose whole purpose was the perpetuation of John Hunter's ideals as they were exemplified in his Museum. Like Clift, he had no care as to who was given the credit so long as the work was done. Burne also found a likeness to Clift in that he was at heart a Londoner who loved to seek out odd corners and old associations around Lincoln's Inn Fields and the Inns of Court. Probably some of his happiest times were spent when, in the genial company of his fellow comparative anatomist, Frederick Gymer Parsons, he wandered about the Inns of Court when the day's work was done and all was quiet in the deserted streets around the precincts of the Temple. An eminent zoologist he most certainly was; but beyond that, all those who knew him best will always remember that he was a gentle and a generous man in whom no thought of self-interest ever intruded in the work to which he devoted his life.

Richard Higgins Burne, the son of a solicitor, was born in London on April 5, 1868. He was educated at Winchester and proceeded to Oriel College, Oxford, where he graduated in natural science in 1889. For two years after leaving Oxford he worked at the Royal College of Science in South Kensington and here came under the influence of that gifted teacher Thomas George Bond Howes, who was then assistant professor of zoology and succeeded Huxley in the professorship in 1895. In 1892, Burne was appointed as anatomical assistant at the Royal College of Surgeons and started his long and faithful service to the Museum that only terminated with his retirement in 1934. Charles Stewart was conservator when Burne joined the staff, and after his death in 1907 there began the long and happy association with Sir Arthur Keith that lasted for the next twenty-three years. In 1908, Burne's office was changed to that of assistant curator and in 1912 to physiological curator.

It is impossible to over-estimate the value of Burne's work in the service of the Hunterian Museum, and had it not been for his carefully compiled descriptive catalogues of the specimens, it would have been impossible to face the task of reconstruction after the terrible losses by enemy action in 1941. The Gold Medal of the College was awarded to him in 1925 and never was it better bestowed.

Among Burne's most important published works are probably those dealing with the minute ramifications of the vascular system of certain fishes. Moreover, these papers are the most characteristic, since they are founded on the minutely perfect dissections in the preparation of which he developed such extraordinary skill. A handbook of his dissections of the Cetacea, edited by Dr. F. C. Fraser, was issued by the British Museum last year. But Burne's real life-work is embodied in the catalogues of the Hunterian Museum and in the collection of unpublished notes and drawings preserved in the College. In 1937, he was appointed a Hunterian Trustee, and until his death his advice and his vast knowledge of the contents of the Museum were invaluable during the critical years of the Second World War and after the disaster that swept away so much of his life's work.

F. Wood Jones

Prof. L. Prandtl, For.Mem.R.S.

The death of Ludwig Prandtl on August 15 at Göttingen has taken from the aeronautical world one of its greatest pioneers, perhaps the greatest of them all in the field of theoretical aerodynamics. He was seventy-seven years of age, having been born in 1875. He was educated as an engineer. He occupied several teaching posts before going to Göttingen in 1907, where he spent the rest of his life and inaugurated a school of aerodynamics and hydrodynamics which soon became famous throughout the world. While he will be remembered chiefly for his theoretical work, he was also a brilliant experimentalist, and he set up at Göttingen a comprehensive aeronautical laboratory which contained the first really successful return-flow wind tunnel. Prandtl had appreciated the two essential features for steady flow in such a tunnel, namely, a fine-mesh honeycomb and a rapid contraction just ahead of the working section. In this tunnel he experimented with airship models at a time when the Germans believed that the heavier-than-air type of aircraft would have a great commercial future. He also studied the drag of spheres and cylinders and was apparently the first investigator to realize the importance of stream turbulence in connexion with the critical Reynolds number of such bodies.

In the theoretical field, Prandtl's original thinking illuminated almost all the fundamental problems of aerodynamics and opened new paths to the many scientists at Göttingen and elsewhere who were able to appreciate his ideas and to follow them up. Among his earlier investigations was the study of the behaviour of an aerofoil of finite span, in which he gave mathematical precision to the ideas outlined years before in Britain by F. W. Lanchester, and

showed how to calculate the effects of aspect ratio of wings, and the interference between the two wings of a biplane or between wings and tailplane. It was a long time before the full significance of this work was appreciated in Britain, perhaps because few of the original workers here had a good knowledge of German; indeed, it was not until the late Hermann Glauert translated and expounded Prandtl's papers that we began to see how great and important were Prandtl's contributions to aerodynamic theory.

It is impossible, in a brief notice, to mention all Prandtl's major contributions; one must be content to single out one or two of the most fundamental of them. He studied the flow of compressible fluids and established the basis of what has now become an investigation of immense extent and of the greatest importance in these days of transonic and supersonic flight. But perhaps his greatest contribution was his concept of the boundary layer and his brilliant mathematical treatment of it. By making certain assumptions which were approximately true in the thin layer of retarded fluid close to the surface of a body, he was able to reduce the intractable general equations of viscous flow to a form which, though still far from simple, was at least amenable to analytical solution in some cases, and to numerical integration in many more. This work led to an understanding of the phenomena underlying the drag of bodies of fine form, such as constitute the wings and fuselages of aircraft, and incidentally explained the diverse results which had been obtained in different wind tunnels in terms of differences in the transition from laminar to turbulent flow in the boundary layer. In the hands of many who have followed Prandtl's lead, we now have a fairly complete theory of aerodynamic drag which is of inestimable value to the aircraft designer.

While the highest tribute is due to Prandtl for his own original researches, no less is due to his outstanding success as a teacher and leader of thought. Among those who have passed through his hands at Göttingen are to be numbered some of the most illustrious original thinkers and research workers in the aeronautical field; to mention but one name, Theodor von Kármán, who has done so much to extend Prandtl's boundary-layer work. Prandtl received many honours in recognition of his work; in Great Britain he was awarded the Gold Medal and the honorary fellowship of the Royal Aeronautical Society, the foreign membership of the Royal Society and an honorary degree of the University of Cambridge.

With his death a very great man has passed from among us and his loss will be mourned by many who knew him personally—and by still more who knew only the value of his work—in all countries where aeronautical science is an important activity.

ERNEST F. RELF

NEWS and VIEWS

Nobel Prize for Medicine and Physiology for 1953

THE Nobel Prize for Medicine and Physiology for 1953 has been awarded jointly to Prof. H. A. Krebs, professor of physiology in the University of Sheffield and director of the Medical Research Council Unit for Research in Cell Metabolism, and Dr. F. Lipmann, head of the Biochemical Research Laboratories, Massachussetts General Hospital.

Prof. H. A. Krebs, F.R.S.

Prof. Krebs has mostly been concerned with the study of metabolic processes by experiments *in vitro*. The first of his two greatest contributions to biochemistry was from Freiburg in 1932, when he elucidated the mechanism of urea synthesis in the liver, by discovering the participation of ornithine, citrulline and arginine through a cyclical process—a concept of unprecedented nature. His subsequent observations on the deamination of amino-acids demonstrated D-amino-acid oxidase, and laid foundations for future studies of the L-acids. In Cambridge in 1935 he proved the synthesis of glutamine from glutamic acid and ammonia in tissue slices. After moving to Sheffield, he announced in 1937 his second major contribution, the citric-acid cycle. Before this, the path of oxidation of carbohydrate from pyruvate onward was unknown; although information was available, its significance was not appreciated. Krebs supplied the missing evidence and the idea, again that of a cycle, and the problem was solved. The citric-acid cycle has stood the test of time, requiring only amplification of detail; it is concerned with oxidation of fat and protein as well as carbohydrate, provides paths for gluconeogenesis and amino-acid synthesis, and is the chief source of metabolic energy. In recent years Krebs's laboratory has been particularly concerned with the movement of substances across biological membranes, and he has studied the uptake of glutamic acid and potassium by tissue cells, processes driven by energy from metabolism. He has also employed isotopes in the quantitative investigation of oxidative phosphorylation and ion transfer.

Dr. Fritz Lipmann

After studying problems of muscle metabolism in Meyerhof's laboratory and of fermentation in the Carlsberg laboratory, Lipmann set the pattern for his future work when in 1937 he began to analyse the oxidation of pyruvate to acetate by bacteria. He found that the oxidation is accompanied by phosphorylation, and announced from Cornell University in 1939 that the 'energy-rich' ester acetyl phosphate is an intermediate. His celebrated article "Metabolic Generation and Utilisation of Phosphate Bond Energy" (1941) organized and developed existing ideas and had the most profound influence on subsequent biochemical thought and research. Moving to Boston, Lipmann realized that acetyl phosphate is not formed in pyruvate oxidation in animal tissues; some other substance had to be sought. By a happy coincidence his own researches led to its identification. Studying the biological acetylation of sulphanilamide, he discovered a new coenzyme, coenzyme *A* (coenzyme of acetylation). Finding that it is a derivative of the vitamin pantothenic acid and a general constituent of living organisms, he quickly realized that it is of fundamental importance in carbohydrate and fat metabolism. By 1946 it was clear that some acetyl derivative stood at the entry to the citric-acid cycle, on the paths of carbohydrate and fat oxidation and ketone-body formation. The idea grew that this was the acetyl derivative of coenzyme *A*,

and was confirmed after the isolation of this substance from yeast by Lynen and Reichert in 1951. In the meantime Lipmann persevered in the purification of coenzyme *A* and as a result its structure has recently been settled.

Plant Pathology at the Imperial College of Science and Technology, London :

Prof. W. Brown, F.R.S.

With his retirement from the headship of the Botanical Department and from his appointment as professor of plant pathology in the University of London, Prof. W. Brown severs a long association with the Imperial College of Science and Technology. A graduate in arts and science of the University of Edinburgh, he went to London to undertake his first researches at South Kensington. He afterwards carried out investigations for the Department of Scientific and Industrial Research and the Ministry of Agriculture. In 1923 he was appointed assistant professor at the Imperial College, and in 1928 professor of plant pathology. On the retirement of Prof. V. H. Blackman, Prof. Brown was invited to become head of the Botanical Department. As a scientist, he showed from the outset a penetrating insight into the problems of mycology and plant pathology. The long series of experimental studies of the physiology of parasitism carried out by him and his research students are characterized equally by a directness and simplicity of approach, and by the profoundly interesting and important results which they yielded. These investigations, with others on the growth of fungi and their variation in culture, and directly practical studies of diseases of crops, together with a teaching course both inspiring and thorough, constitute a landmark in this field of botanical endeavour. For Brown's teaching and research have not only aroused the enthusiasm of his own students but have also reached a much wider body of scholars during the past thirty years. The work published in his own name, however, gives only a meagre and partial impression of his actual achievement ; for throughout the years his laboratories were thronged with research students from all parts of the world, and he gave all of them of his best without stint. His general appreciation and comprehension of the problems of plant pathology in major crops were enhanced from time to time by wide travel, both in temperate and tropical regions. His eminence in his own particular field, and in the field of scholarship generally, has been recognized by his presidency of the British Mycological Society in 1933, of the Association of Applied Biologists in 1944 and 1945, and of Section K of the British Association in 1951, and by his election to the Royal Society in 1938. At this time, Prof. Brown will be thought of with affection and respect by past students, colleagues and associates in every part of the world, and their good wishes will go with him into what it is hard to conceive of as being other than an active retirement.

Prof. P. H. Gregory

Prof. Brown will be succeeded by Dr. P. H. Gregory, a former student and one who has himself made a distinguished career in mycology and plant pathology. After an initial education at Brighton Technical College, which he entered in 1924, Gregory undertook advanced study in the Royal College of Science in 1928, working in plant pathology under the direction of Prof. Brown. An opportunity of continuing his studies in Canada presented itself in 1931 when Gregory became attached to the Manitoba Medical College to undertake research in medical mycology under Dr. A. M. Davidson and the late Prof. A. H. Reginald Bullock. Dr. Gregory returned to an appointment in England in 1935, at Seale Hayne Agricultural College, the particular work being the investigation of diseases in outdoor horticultural crops in the south-west of England. On the outbreak of war he joined the scientific staff of the Agricultural Research Council to work on problems of potato virus diseases. In 1945 his experience was extended to industrial mycology when he was seconded to work with I.C.I. (Pharmaceuticals), Ltd., for one year to organize a research team working on penicillin and other antibiotics. Thereafter, in 1948, he was appointed to the staff of the Department of Plant Pathology at Rothamsted Experimental Station. Dr. Gregory's research has ranged widely over the fields of mycology and plant pathology. His published work, which includes some fifty scientific papers published independently and jointly, relates to plant pathology, plant virus diseases, medical and general mycology. His post at Rothamsted has given him practical experience in, and contact with, the general problems of agricultural as well as with the special problems of plant diseases. Dr. Gregory was elected president of the British Mycological Association in 1951 and edits the Society's *Transactions*, and he was formerly chairman of the Plant Pests and Diseases Committee of the Association of Applied Biologists. He will take to his new post critical judgment and powers of organization based on a wide and varied experience.

Scientific Liaison Officer in Wales :

Dr. R. O. Jones

The Department of Scientific and Industrial Research has created a new post by the appointment of Dr. R. O. Jones to be its resident liaison officer in Wales. Dr. Jones took up his new duties on November 1, his office being in the Welsh Board of Health Building, Cathays Park, Cardiff. His task will be to study the industrial position in Wales with the view of assisting in the identification of industrial problems amenable to research and in the application of existing knowledge and research facilities to meet Welsh needs. To this end, he will work in close collaboration with other government departments in Wales and with Welsh industrial and regional organizations. It is hoped to provide a link between Welsh firms and the research laboratories of the Department of Scientific and Industrial Research, the research associations and others, and to make more readily accessible in Wales the scientific information already available within the Department's organization. Dr. Jones has already spent more than a year in a preliminary examination of Welsh problems in these fields. A graduate of University College, Swansea, and of King's College, London, he has in recent years been a member of the headquarters staff of the Department of Scientific and Industrial Research. Before that he was concerned in the development and utilization of non-ferrous minerals, after having served for some years in the Geological Survey and Museum. He is a member of the Court of the University of Wales, of

the Court of Governors of the University College of South Wales and Monmouthshire, and of various educational and other bodies associated with the Principality.

The Carnegie United Kingdom Trust: Mr. J. Wilkie

MR. JAMES WILKIE is due to retire from the secretaryship of the Carnegie United Kingdom Trust on March 31, 1954, when he will be succeeded by Mr. D. N. Lowe (*Nature*, October 31, p. 794). Mr. Wilkie became secretary of the Trust in 1939. He had to face almost immediately the disorganization caused by the War, which put a sudden stop to many of the major projects of the Trust but, at the same time, enabled useful work to be done in new fields. Wilkie helped to deal with this situation quickly and effectively, and he tackled with success and enthusiasm the Trust's scheme to help amateur choral and orchestral societies, professional orchestras and Sadler's Wells. The Trust might claim that it was for a time the 'Arts Council' of the country, and Wilkie was a member of the first C.E.M.A. committee under Dr. Tom Jones which ultimately took over, as the Arts Council, many of the concerns that had been helped by the Trust. Wilkie was always quick to react to new ideas and suggestions and to form judgments on their merits. He succeeded early in his career as secretary of the Trust in establishing most cordial relations with other Trusts and with all officials with whom he came into contact. During his time as secretary of the Trust, Wilkie has taken an active interest in different forms of social work and in the adult education movement. He has served on numerous committees and has been a valuable member of them. He has taken a great interest in many aspects of library work, and in 1951 was president of the Library Association.

Meteorological and Magnetic Survey of the Oceans

DR. B. M. CWILONG, associate professor of physics in the University of British Columbia, has just sailed from Hamble near Southampton in the *Princess Waimai*, a 48-ton 74-ft. yawl, to begin a magnetic survey of the Pacific and other oceans. For this purpose a non-magnetic vessel is required; none has been available since the American non-magnetic ship *Carnegie* was burned out off Samoa in 1929, and Dr. Cwilong has designed a small 34-ft. vessel, *Non-magnetic III*, which is nearing completion in Vancouver. The *Princess Waimai* will serve as a base-ship when the two ships join forces in Hawaii, for the survey work in the Pacific, which is scheduled to take three years. Dr. Cwilong graduated at the University of Warsaw, and later carried out research at the Warsaw Institute of Experimental Physics, specializing in spectroscopy, and at the National Meteorological Institute. He was attached as a scientist to the Polish training ship *Dar Pomorza* during 1933–34 and circumnavigated the Atlantic, and in the following year, on the invitation of the Swedish authorities, he joined the crew of the famous Swedish training four-master *Abraham Rydberg*. During the Second World War he was attached as an expert to the Polish Air Force and eventually reached Britain. He then went to the Clarendon Laboratory, Oxford, where he studied the formation of ice particles in cloud. Since the War, Dr. Cwilong has spent three years in New Zealand, as a senior lecturer in physics at Victoria University College, Wellington, and a further three in the University of British Columbia as associate professor and head of the low-temperature laboratory. Dr. Cwilong hopes to take meteorological and atmospheric electricity measurements on the first part of his voyage, to the Bahamas, and he may investigate the formation of thunder-clouds and waterspouts in the Doldrums. Part of the scientific equipment has been provided by the Air Ministry.

Royal Society of Edinburgh: Officers for 1953–54

THE following have been elected officers and members of council of the Royal Society of Edinburgh for the session 1953–54: *President*, Prof. James Kendall; *Vice-Presidents*, Prof. J. H. Gaddum, Prof. James Ritchie, Prof. R. C. Garry, Prof. W. M. Smart, Dr. A. H. R. Goldie and Prof. C. M. Yonge; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Prof. J. Norman Davidson and Dr. T. R. Bolam; *Treasurer*, Mr. A. W. Young; *Curator of Library and Museum*, Dr. Douglas Guthrie; *Members of Council*, Prof. Norman Feather, Sir Godfrey Thomson, Dr. D. P. Cuthbertson, Principal H. B. Nisbet, Prof. T. C. Phemister, Dr. J. B. Simpson, Prof. Meirion Thomas, Dr. J. M. Cowan, Dr. David Jack, Prof. J. M. Robertson, Prof. D. Whitteridge and Prof. E. M. Wright.

Mathematics and Science Teachers in Scotland

IN *Nature* of October 24, p. 750, a note was published referring to a committee to advise the Secretary of State for Scotland on the supply of mathematics and science teachers in Scotland. The full committee is as follows: Sir Edward Appleton (*chairman*); Prof. E. T. Copson, professor of mathematics, University of St. Andrews; Prof. J. M. Graham, Lord Provost of Aberdeen; R. L. Gwilt, general manager of the Scottish Widows' Fund and Life Assurance Society, and president of the Faculty of Actuaries in Scotland; Dr. W. J. Jenkins, chairman of the Nobel Division of Imperial Chemical Industries, Ltd., Ardeer; A. G. McKimmie, headmaster of Allan Glen's School, Glasgow; W. G. Marskell, superintendent of the Research Department of Babcock and Wilcox, Ltd., Renfrew; Dr. A. R. Murison, rector of Marr College, Troon, ex-president of the Educational Institute of Scotland; Dr. H. B. Nisbet, principal of Heriot-Watt College, Edinburgh; J. N. Toothill, general manager of Ferranti, Ltd., Edinburgh; H. P. Wood, director of studies, Jordanhill Training College, Glasgow; and A. L. Young, director of education, Aberdeenshire. A. G. Roger and J. B. Beaumont, Scottish Education Department, have been appointed assessor and secretary respectively to the Committee. Communications in connexion with the Committee should be addressed to the Secretary, Committee on the Supply of Teachers of Mathematics and Science, St. Andrew's House, Edinburgh 1. The terms of reference of the Committee are: "to consider and report on the causes and effects of the present and prospective shortages of teachers of mathematics and science in Scottish secondary schools and to suggest remedies". The Committee will maintain liaison with the National Advisory Council, which deals with the supply of teachers in England and Wales, and with the Advisory Council on Scientific Policy, which advises the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy.

Myxomatosis Advisory Committee

In reply to a question in the House of Commons on October 29, Sir Thomas Dugdale, Minister of Agriculture and Fisheries, stated that he and the Secretary of State for Scotland have set up the following committee to advise on the problems arising in connexion with myxomatosis in rabbits and the action that should be taken by the Government: Lord Carrington (*chairman*), Lord Dundee, Lord Merthyr, Dr. C. H. Andrewes, H. Collison, Dr. J. W. Evans, Prof. R. E. Glover, H. Gardner, J. Scott Henderson, the Hon. Mrs. George Lane, C. T. Plumb, J. N. Ritchie, J. C. Sandford, W. H. Senior, Major R. Verney and Harold Woolley. He added that all reasonably practicable steps are being taken to stamp out the only two known outbreaks of the disease that have recently come to light in Kent. Measures are also being examined for the protective inoculation of tame rabbits in case myxomatosis should spread. Future policy will be determined in the light of recommendations from the new Advisory Committee, which is meeting immediately.

Scottish Postgraduate Scholarships in Agriculture

The Department of Agriculture for Scotland has awarded the following postgraduate scholarships in agricultural subjects, tenable for periods up to three years, at the institute shown: *Husbandry*, Q. Brown and P. M. Bremner (School of Agriculture, Cambridge), W. J. Donald, N. C. Lawson and T. M. Sutherland (University of Reading); *Agricultural Engineering*, J. Roddan and J. H. S. Torrance (King's College, University of Durham). The current awards of the following have been continued: *Husbandry*, J. Eadie (University of Edinburgh), D. Stuart Hay (University of Wisconsin), R. Laird (Ohio State University), T. D. MacLean (University of Reading), and R. R. Shepherd (Rhuakura Animal Research Station, Hamilton, New Zealand); *Agricultural Economics*, A. V. Vickery (Agricultural Economics Research Institute, Oxford).

International Botanical Congress, 1954

The International Botanical Congress to be held in Paris in July 1954 will include, among its sections, one dealing with phycology. The preliminary programme of its meetings includes comparative cytology and biochemistry in relation to classification, algal life-cycles, classification of Chlorophyceae, algal evolution in relation to the origin of vascular plants, fossil algae, ecology and geographical distribution of marine and freshwater algae. Special excursions, in relation to marine and freshwater algae, are planned both to precede and follow the congress. Summaries of original communications, not exceeding two hundred words in length, should be sent to Prof. Feldmann (marine) or Dr. P. Bourrelly (freshwater), at the Institut Oceanographique, 195 rue St. Jacques, Paris 5, before January 15, 1954.

International Congress of Genetics

At the final session of the International Congress of Genetics recently held at Bellagio, Italy, the following resolution was unanimously passed: "The Congress asks the International Committee not to recommend that the next Congress be held in any country to which it may be expected that scientists would be refused permission to enter on grounds of race, nationality, religion, place of birth, or political associations past or present".

Announcements

Dr. Harold King, C.B.E., F.R.S., late chemist to the Medical Research Council, has been awarded the Addingham Gold Medal for 1952 by the trustees of the Wm. Hoffman Wood Trust for his work on the curares and the decamethonium compounds leading to the relief of pain and suffering in humanity.

Mr. Charles Biddolph is retiring in December from the post of senior technician, after forty-seven years service in the Department of Zoology, King's College, London. Former students and members of staff are invited to attend a dinner to be given in his honour on December 11. Those wishing to attend should write to Dr. M. E. Brown, Department of Zoology, King's College, London, W.C.2, by November 25.

Sir Roger Duncalfe, chairman of British Glues and Chemicals, Ltd., has been elected president of the British Standards Institution in succession to Viscount Waverley, whose three-year term of office has ended.

Mr. Henry S. Darling has been appointed as head of the Hop Research Department of Wye College (University of London), near Ashford, Kent, and will be taking up his duties in April next year. Mr. Darling, who is a graduate of Queen's University, Belfast, is at present senior lecturer in zoology in the Faculty of Agriculture of the University College of Khartoum, having previously served with the Insect Infestation Division of the Ministry of Food, with the Middle East Anti-Locust Unit, as entomologist in the Research Division of the Department of Agriculture in Uganda and also in a similar capacity with the Sudan Ministry of Agriculture.

The Meldola Medal, which is the gift of the Society of Maccabæans and is normally given annually, is being offered for award early in 1954 to the chemist who, being a British subject and less than thirty years of age on December 31, 1953, shows the most promise, as indicated by his or her published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before December 31. Communications should be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal".

The autumn general meeting of the Iron and Steel Institute will be held in the offices of the Institute (4 Grosvenor Gardens, London, S.W.1) during November 24–25 and will be followed on the afternoon of November 25 and the whole of the succe ding day by a symposium on the process of sintering. Further information can be obtained from the Secretary of the Institute at the above address.

The third international congress of Alpine meteorology will be held in Davos, Switzerland, during April 12–14, 1954. The four topics to be considered in detail at the meeting will be synoptic meteorology, radiation, bioclimatology, and snow and ice. Davos is the most important climatic station in Switzerland and is the site of two important institutions: the Physico-Meteorological Observatory, Davos-Platz, and the Federal Institute for the Study of Snow and Avalanches, Weissfluhjoch-Davos. Those wishing to read papers should write as soon as possible to Dr. W. Mörikofer, Observatoire physico-météorologique, Davos.

ANTICHOLINESTERASES

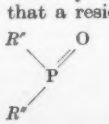
A SYMPOSIUM on "Anticholinesterases", jointly arranged by the British Pharmacological Society and the Fine Chemicals Group of the Society of Chemical Industry, was held in the lecture theatre of the Wellcome Foundation, London, during March 27–28. The symposium was divided into four sessions, at the first two of which the chemical features of anticholinesterases which confer inhibition and the mode of their action *in vitro* were discussed, and for the third and fourth sessions the acute effects and the chronic effects, respectively, in the mode of action *in vivo* were considered. The full text of the contributions will be published in due course by the Society of Chemical Industry.

Chemical Features which confer Inhibition : Structure Action Relations

Prof. J. H. Gaddum gave a historical review of the discoveries of anticholinesterases, starting with the first known one, eserine or physostigmine, which was originally obtained from the ordeal beans used in Old Calabar in Nigeria for the trial of witches. When one native accused another of being a witch, a council of chiefs was summoned and the accused was asked to state his case. The usual reply was a demand for trial by ordeal, which took place in public and was watched by a crowd of onlookers. The accused swallowed the beans, either as the dry kernel or in the form of an infusion. If this produced vomiting, the prisoner was acquitted and the accuser might be made to go through the same ordeal. Those whose consciences were clear were confident of their ability to vomit and were more likely to do so than those with guilty consciences who ate slowly and without confidence so that they absorbed the poison and died. According to T. R. Fraser (1862) about a hundred and twenty natives died in this way each year out of a population of about a hundred thousand. The beans were brought to Europe in 1840 and first investigated by Sir Robert Christison, who was professor of materia medica in Edinburgh at that time.

Prof. Gaddum divided the anticholinesterases into three groups : drugs allied to eserine which combine reversibly with the enzyme ; active organic phosphates the actions of which are irreversible *in vitro* ; and drugs like octamethylpyrophosphoramide ('Ompa'), which are not active by themselves but are converted into active, organic phosphates in the body.

After this introduction, Mr. A. H. Ford Moore concentrated on compounds containing phosphorus. He outlined their development from derivatives of phosphofluoridic acid, culminating during the Second World War in the discovery of high activity of the di-*iso*propyl ester, di-*iso*propyl fluorophosphonate. At the same time, work had progressed in Germany, where Schrader had found that certain derivatives of phosphoramidic acid show insecticidal properties. On the basis of these two types, further developments have taken place, and Mr. Moore summarized the present-day structure–activity relationship in this field by pointing out that a residue



is essential, as suggested by Schrader, together with an acyl group. The R' is preferably an alkoxy group, while the R'' can be an alkylamino group, another alkoxy group, a methyl group, and so forth. The so-called acyl group can be a fluorene, a nitrile, another phosphate radical, etc. It is only necessary that, at the moment the compound comes into contact with the enzyme, the acyl group is removed and the group containing the phosphorus attached to a specific group of enzyme.

Mr. A. W. D. Avison considered anticholinesterases containing at least one aromatic ammonium group, and using the concept developed by Bergman, Nachmansohn, Wilson and others—namely, that the true enzyme possesses at least one grouping called the anionic side which is capable of reacting with the ammonium group, and another called the esteratic side reacting with carbamate, and possibly identical with the grouping reacting with the phosphorus-containing drugs—he gave a complete review of the work in this field, starting with the basic contributions by Stedman and Stedman and continued by Aeschlimann and Reinert with their discovery of prostigmine. Mr. Avison then touched upon further variations, particularly on substances, mentioned later in the discussion by F. C. Copp, which have two quaternary ammonium groups in one molecule, and on those claimed by Funke, Depierre and Krucker to be many times more active than other drugs in this field. He also mentioned the phosphostigmines having ammonium groups and dialkylphosphate groups, the latter in place of the carbamate.

In the discussion, Drs. G. S. Hartley and B. C. Saunders referred to the phosphorus-containing compounds, while Drs. A. L. Morrison and F. A. Atherton divided their attention between the ammonium- and phosphate-bearing substances. Finally, K. Bulloch, who had investigated the series of alkylating cytotoxic substances including nitrogen mustards, confirmed indirectly the present-day specificity of aromatic quaternary ammonium compounds with carbamates or phosphates or phosphorus-containing substances as the most potent anticholinesterases, because none of his substances mentioned possesses any remarkable anti-enzyme activity.

In summing up the first session, Prof. F. Bergel pointed out that the over-all impression gained was the presence of two sites in the cholinesterase, at least in the true cholinesterase, with which the drugs make contact : an 'anionic' group which reacts with the quaternary ammonium groups of the inhibitors ; and an 'esteratic' group which combines with the O-acetyl of acetylcholine or with the carbamate groups of the 'stigmines'. This group is also the one which undergoes phosphorylation by the phosphorus-containing anticholinesterases. Looking at a future working programme, further studies of the purification of the cholinesterases would be desirable. It would also be useful to have a definite estimate of the stoichiometry relation between drugs and enzymes, and to carry out tests with substances which have two or more phosphate groups or three or more ammonium groups in the same molecule, if possible at the right distance, as indicated by present speculations on the enzyme structure.

Mode of Action of Anticholinesterases *in vitro*

The chairman, Dr. E. Stedman, pointed out some of the anomalies in the nomenclature of the cholinesterases, and later in the discussion Mr. W. K. Berry brought out some of the difficulties of fitting all the cholinesterases into the classical 'true' and 'pseudo' types.

The general theme which emerged from this session of the symposium was that the following general reaction may represent the steps involved in the hydrolysis of substrates and the inhibition by reversible inhibitors such as prostigmine, etc., or by organo-phosphorus compounds: $E + A_{(x+y)} \xrightarrow{(1)}$

$$[E \cdots A_{(x+y)}] \xrightarrow{(2)} A_y + E \cdots A_x \xrightarrow[+H_2O]{(3)} E + A_x,$$

where E is cholinesterase, A the substrate, etc., and x and y are the acid and alcohol groups of ester.

After pointing out many of the experimental difficulties in studying the inhibition of physostigmine, prostigmine and related compounds, Dr. F. Hobbiger showed that these inhibitors are hydrolysed at their ester group. However, reaction (3) is slow, while reaction (1) is fast, so that the enzyme is inhibited. This point was further elaborated in the discussion by Dr. H. O. Michel, who described some of his work with high enzyme and inhibitor concentrations. Under these conditions the increase in activity obtained upon dilution is mainly due to the progress of reaction (3) rather than to the reversal of reaction (1). Dr. Hobbiger also pointed out that inhibitors with no ester group, such as choline, are true reversible inhibitors since reactions (2) and (3) are not involved. In discussing the organo-phosphorus inhibitors, Dr. W. N. Aldridge showed that these substances are not specific inhibitors for cholinesterase but are general inhibitors for enzymes possessing carboxylic esterase activity. The evidence available was shown to be in agreement with the view that cholinesterase is phosphorylated during inhibition—that is, reactions (1) and (2) are fast, while reaction (3) is very slow. The high energy of activation associated with the return of enzyme activity after inhibition with dimethyl *p*-nitrophenyl phosphate is in agreement with such a process. The factors discussed which affect inhibition and the return of enzyme activity included the properties of the particular enzyme, the stability of the inhibitor and the particular groups (other than the labile group) attached to the phosphorus atom. Dr. Aldridge also compared the inhibitory process for cholinesterase in relation to the enzymes which hydrolyse organo-phosphorus compounds rapidly.

Finally, Dr. B. A. Kilby discussed the metabolic conversion of certain organo-phosphorus compounds into anticholinesterases. Octamethylpyrophosphoramide ('Schradan') has little *in vitro* activity against cholinesterase, but after injection into mammals the animal dies with symptoms of acetylcholine poisoning. Evidence was given that 'Schradan' is converted *in vivo* to a powerful anticholinesterase, and the theory that this conversion involves amine-oxide formation was examined. The evidence for the metabolic conversion of diethyl *p*-nitrophenyl thiophosphate (parathion) to a more active inhibitor was also reviewed. This aspect was extended in the discussion by Dr. J. C. Gage, who showed the results of his experiments indicating that it is converted to the highly active diethyl *p*-nitrophenyl phosphate (paraoxon, *E*.600). There is, however, no information about the enzyme systems involved in these oxidations.

In summing up the session, Dr. H. Blaschko referred to the usefulness of the Wilson–Bergmann model of cholinesterase in the analysis of the different types of anticholinesterases. He hoped that the specific inhibitors might help in the understanding of the biological significance of the various cholinesterases. The recognition that coenzyme A is of importance in acylation reactions other than acetylations makes it possible that compounds like succinylcholine or benzoylcholine may be the normal substrates of those cholinesterases which are not specifically involved in the metabolism of acetylcholine.

Mode of Action of Anticholinesterases *in vivo*: Acute Effects

The chairman of the third session, Dr. W. Feldberg, reviewed the factors which determine the symptomatology of the anticholinesterases. First, they may have side actions which are not due to inhibitors of cholinesterase. Second, although the most striking effects resulting from inhibition of cholinesterase are those due to accumulation of acetylcholine, there may be other changes either in the function of cholinergic nerves or in the reactivity of the effector structures resulting from the fact that the products of hydrolysis, choline and acetic acid, are no longer available at the site of acetylcholine liberation. Finally, the symptoms of inhibition of cholinesterase may vary according to the properties of a given anticholinesterase, whether it inhibits selectively the pseudo or the true cholinesterase, whether it is soluble in water, or in lipoid media or in both and in what proportion, and whether it is hydrolysed in water or inactivated in the body by some other means. Referring to the terminologies proposed for the two groups or families of cholinesterases, Dr. Feldberg stressed that, from the physiological point of view, the terms 'pseudo' and 'true' cholinesterase, which are generally accepted in Britain, are more satisfactory than any other so far proposed, and he hoped that no new terminologies would be introduced before we know the physiological substrate or substrates of the pseudocholinesterases.

The following speaker, Dr. H. Collumbine, pointed out that failure of respiration is the predominant factor for the lethal effects of anticholinesterase. He gave a detailed analysis of the importance of bronchospasm, neuromuscular block and central depression of respiration for the various anticholinesterases. The important role of central failure was stressed, and its possible mechanisms were discussed.

Dr. J. M. Barnes then reported on the effects of repeated doses of some anticholinesterases in anæsthetized dogs, rabbits and rats. The animals may be saved from the effects of an otherwise lethal dose of paraoxon (*p*-nitrophenyl diethyl phosphate) by a short period of artificial ventilation and will then withstand further doses of the inhibitor without respiratory effects. He then discussed the relation between neuromuscular block and inhibition of cholinesterase on the isolated rat diaphragm, and the relation between enzyme inhibition and the occurrence of irregular movements in the isolated diaphragm and in the whole rat.

Dr. M. Parkes was concerned with the protective effect of atropine and hexamethonium against the toxic effects of neostigmine and tetraethyl pyrophosphate (TEPP). Further, from his findings in guinea pigs that decamethonium and succinylcholine

produce neuromuscular block which can be relieved by neostigmine and 'Tensilon' but not by tetraethyl pyrophosphate or di-*iso*propyl fluorophosphonate, he infers that the simple explanation of the anticurare effect of anticholinesterase drugs is not entirely adequate.

In the discussion, Dr. F. Hobbiger compared the *in vitro* and *in vivo* activities of the anticholinesterases tetraethyl pyrophosphate, and tertiary and quaternary aminophenyl-, quinolyl- and dialkyl phosphates. He discussed the relation between *L* 50 *in vitro* and *D* 50 *in vivo*, the duration of action as a function of the dialkyl side-chain (the duration increases with the length of the chain) and reactions not due to cholinesterase inhibition. Dr. W. L. M. Perry discussed experiments on the output of acetylcholine from the perfused superior cervical ganglion of the cat, which lead him to believe that the choline formed from the acetylcholine released by preganglionic nerve stimulation is immediately resynthesized to replenish the stock of acetylcholine 'available' for release. In the presence of eserine, hydrolysis of acetylcholine is prevented and the failure to form choline is suggested as the cause for the fatigue which occurs under these conditions in the transmission in autonomic ganglia. Another interesting observation was reported by Dr. E. J. Zaimis. She has found that, after neostigmine, even when used in very small doses, it becomes necessary to increase the voltage applied to a motor nerve in order to obtain a maximal response from the muscle. This effect is not explained by inhibition of cholinesterase and suggests that neostigmine may interfere directly with the permeability changes which occur during activity in the nerve membrane.

Next, Dr. M. Pickford described the use of di-*iso*propyl fluorophosphonate in order to obtain information about the chemical transmission of nerve impulses in the supraoptico-hypophyseal system of the hypothalamus. When injected among the supraoptic cells of both sides into dogs, di-*iso*propyl fluorophosphonate caused oliguria or anuria, followed by a period of polyuria lasting for several days—in other words, a transient diabetes insipidus. During this period, intravenous injections of acetylcholine did not produce their usual oliguric effects. From these and other findings Dr. Pickford could conclude that acetylcholine is the transmitter of at least one group of nerve fibres impinging on the supraoptic nerve cells. The problem discussed by Dr. J. Duff concerned the occurrence of acetylcholine in blood of atropinized animals after injections of paraoxon and the correlation, or lack of correlation, between acetylcholine levels of blood and the insensitivity which develops with successive injections of this anticholinesterase. Dr. J. Elkes reported on the effects of intraperitoneal injections in rats of tetraethyl pyrophosphate, di-*iso*propyl fluorophosphonate and Nu 1250 on the cholinesterase inhibition in different parts of the brain. With tetraethyl pyrophosphate, inhibition never exceeded 62 per cent in any part; with the two other inhibitors there was greater inhibition (70 per cent) in the midbrain than in any other brain region, but the unequal distribution was only seen when the doses given were not too high, otherwise inhibition became more uniform.

Dr. A. Todrick discussed the effects of thirty antagonists of acetylcholine on the cholinesterases of rat tissue. Curariform drugs were found to be mainly inhibitors of the true cholinesterase, parasympatholytic drugs mainly of the pseudocholinesterase, but Dr. Todrick said that he did not want to suggest that this difference is responsible for the pharmacological effects of these substances. Mr. D. K. Meyers's contribution concerned the problem of whether the pseudocholinesterase is responsible for destruction of acetylcholine in the intestinal wall. From his experiments with Dr. Admiral, in which the inhibition of true and pseudocholinesterase by different inhibitors was correlated with the motor activity produced in the intestinal wall, the conclusion was reached that the pseudocholinesterase does not take this role in the intestinal wall but that the enzyme responsible is the true cholinesterase, partial inhibition of which is sufficient to lead to symptoms of acetylcholine accumulation.

In summing up this session, Sir Charles Lovatt Evans pointed out that biochemical studies have not provided all the answers that are wanted. The classification of enzymes concerned in the hydrolysis of acetylcholine and other esters is puzzling in the extreme, and it is clear that the distinction into true and pseudocholinesterases by no means gives the full picture. The physiologist always hopes that pharmacological agents may provide tools for a physiological analysis finer than is possible by other means of approach, and there were examples in the symposium of that type of investigation. He said that he would like to see in such investigations a clear distinction between the effects of agents which paralyse alternatively either the true or the pseudo type of cholinesterase, however vague the various sub-types might be. The rather indefinite functions of the pseudo type might thus be made out. His own experiments with the submaxillary glands have indicated that the inactivation of the pseudo type of enzyme has but little effect, as compared with the effects of agents which inactivate the true enzyme, or both enzymes. Unfortunately those agents which inactivate the true and have very little effect on the pseudo enzyme are very easily reversible, so that the effects are difficult to localize. He wondered whether some of the data which have been obtained from the perfused ganglia should not be repeated with some other agent less easily reversible than eserine, which is the one usually employed, and with some other tissues or organs, if suitable ones could be found.

Mode of Action of Anticholinesterases *in vivo*: Chronic Effects

The chairman for the fourth session, Prof. G. R. Cameron, reminded his audience that the investigation of chronic toxicity is still one of the most difficult and uncertain problems in the field of toxicology for three very good reasons: clinical changes are almost invariably unpredictable, there being no evidence of any correlation between the chemical structure, physical characteristic and toxic effect that can be made use of; on account of the latent period which may elapse before clinical and other features become apparent; and on account of the insidious nature of chronic toxic action.

In so far as the latter is concerned, a wide variety of changes may be induced ranging from vague ill-health, anæmia, growth and metabolic disturbances to carcinogenesis. The subject is also made difficult because of the lack of a short-cut to the assessment of toxic effects. At present we have to depend upon prolonged animal experiments or astute clinical diagnosis. For that reason Prof. Cameron urged upon chemists interested in this field the necessity of

working out simpler methods for the assessment of dangerous effects.

Following Prof. Cameron, Prof. A. Wilson discussed the chronic muscarinic, nicotinic and central effects of di-*iso*propyl fluorophosphonate in normal subjects and compared the effects of this substance and neostigmine in patients with myasthenia gravis and the changes accompanying these effects in the cholinesterase levels of blood. He reported, further, on the effects of di-*iso*propyl fluorophosphonate on the central nervous system of normal subjects and of patients with functional psychoses. Dr. L. Bidstrup and Dr. J. A. Bornell then gave a detailed description of the paralysis which occurs in patients poisoned by the two cholinesterase-inhibitors tri*ortho*cresyl phosphate (TOCP) and *bis* (mono*iso*propylamine) fluorophosphine (mipafox).

Poisoning by tri*ortho*cresyl phosphate has been known for many years and was the cause of the well-known ginger paralysis which occurred in the United States of America in 1930; several thousand people were affected and there were some deaths. In these cases gastro-intestinal symptoms were followed after a latent interval of two to three weeks by peripheral neuritis and led in many cases to permanent disability due to lesions in the central nervous system affecting particularly the pyramidal and cerebellar tracts of the spinal cord.

In the search for new organic phosphorus compounds which would be effective as insecticides but less toxic than parathion and other related substances already in use, *bis* (mono*iso*propylamine) fluorophosphine was discovered. Three people employed on the manufacture of a small quantity of this compound by a pilot process developed the symptoms and signs of acute organic phosphorus poisoning. Two developed paralysis in the third week after the acute episode.

Both tri*ortho*cresyl phosphate and *bis* (mono*iso*propylamine) fluorophosphine are selective inhibitors of pseudocholinesterase and were found to cause demyelination; the lesions in the central nervous system of man in poisoning by the latter are confined to the pyramidal tracts, whereas in poisoning by the former the spino-cerebellar tracts are affected as well and there are lesions in the cerebellum. It is, however, the opinion of Dr. Bidstrup and Dr. Bornell, based on the clinical findings and electromyographic studies in the cases of poisoning by *bis* (mono*iso*propylamine) fluorophosphine, that the central nervous system damage and peripheral nerve lesions are secondary to prolonged failure of conduction at the neuromuscular junctions.

The demyelination was discussed in detail by the next speaker, Dr. F. A. Denz, who reported on these pathological changes in peripheral nerves and in the central nervous system in various species. The tracts affected vary in different species. The lesions were obtained with tri*ortho*cresyl phosphate, di*iso*propyl- and diethyl-fluorophosphonate and with *bis* (mono-*iso*propylamine) fluorophosphine. The problem was discussed whether the primary effect is on the myelin sheath or on the axon, and why some tracts are affected and others not. In the chicken the same tracts are involved as in beriberi. Closely connected with this problem were the following contributions given by Prof. R. H. S. Thompson and Dr. A. N. Davison. Prof. Thompson showed that the paralysis produced by tri*ortho*cresyl phosphate is not due to inhibition of true cholinesterase at the motor end-plate, as originally suggested by Bloch. The demyelination can also not be fully explained by inhibition of pseudocholinesterase, because when using other selective inhibitors of this enzyme (for example, *iso*octamethylpyrophosphoramide), although inhibition of the central nervous system of the experimental animals was as strong as after tri*ortho*-cresyl phosphate, demyelination did not occur. Similarly, Dr. Davison, based on his results obtained with cholinesterase-inhibition of the central nervous system of birds by tri*ortho*cresyl phosphate, *bis* (mono*iso*propylamine) fluorophosphine and *iso*octamethylpyrophosphoramide, came to the same conclusion that prolonged inhibition of pseudocholinesterase does not appear to be a prerequisite for demyelination. Complete inhibition and subsequent fast recovery of the cholinesterase activity could be produced by the demyelinating compounds tri*ortho*-cresyl phosphate and *bis* (mono*iso*propylamine) fluorophosphine, as well as by the non-demyelinating compound *iso*octamethylpyrophosphoramide. Judged by their effects on the pseudocholinesterase of the central nervous system, these compounds are apparently indistinguishable. Tri*ortho*cresyl phosphate is different in that it produces a prolonged fall in pseudocholinesterase activity. It also differs, together with *iso*octamethylpyrophosphoramide, in not producing any acute symptoms during the first few days after injection. Furthermore, it has not been possible to produce paralysis in the rat, despite prolonged and complete inhibition of pseudocholinesterase. The mechanism underlying demyelination thus remains obscure; but it is interesting and probably significant that, so far, only selective inhibitors of pseudocholinesterase have produced such late lesions in the central and peripheral nervous system.

In the subsequent discussion Dr. G. S. Hartley pointed out that the two organo-phosphorus compounds with which the late development of paralytic effects has been most clearly established are at opposite ends of the scale of water- and oil-solubility. *Bis* (mono*iso*propylamine) fluorophosphine is the most completely water-favourable of all the compounds examined, and tri*ortho*cresyl phosphate the most completely lipophilic. Dr. Aldridge's indication that the latter substance is first converted by the body into another compound may throw some light on this apparent anomaly. Prof. Biggart's closing remarks dealt with the medical and pathological aspects of the anticholinesterases, and he pointed out some of the pertinent, unsolved problems.

RATIONS FOR LIVESTOCK IN BRITAIN

THE Scottish Group of the Nutrition Society organized a conference on "Problems in providing Rations for Britain's Livestock", which was held in Aberdeen, centred on the Rowett Research Institute, during October 1–2. Prof. R. G. Baskett was in the chair, and papers were read by J. N. Aitken, A. S. Barker, S. Bartlett, K. J. Carpenter, J. A. Crichton, J. Duckworth, A. Eden, W. S. Ferguson, W. Holmes, H. R. Humphries, W. R. Muir and K. L. Robinson.

The time of the conference was opportune, for domestic and foreign trade in feeding stuffs and compounds has largely passed out of the control of the Ministry of Food and back to the hands of

private traders. The Ministry's regulations no longer control the types of feeding compounds that can be manufactured or the kinds and amounts of ingredients that can be included. In addition, the use of certain antibiotics as growth stimulants in stock feeding has recently been legalized.

Circumstances have changed since farmers and compounders were last free to buy feeding stuffs and to use their skill and experience to combine them into balanced rations for farm stock. Since then the feeding stuffs moving through the channels of international trade have changed in volume, supplies of some remaining abundant, supplies of others being greatly diminished. Even trading in exportable surpluses that are plentiful is not free from difficulty, since the official policies of foreign countries burdened with these commodities are not materially affected by relaxation of controls in Britain. Such problems that faced the Ministry of Food have not disappeared with the return of trade to private hands.

The pattern of Britain's agriculture has changed since pre-war days. With more intensive use of land and greater domestic production of feeding stuffs, with greater numbers of livestock and their greater reliance on home-grown feeds, many feeding problems are different from those before the War. But none of these problems has been neglected. After the first abrupt changes in 1939 other changes came gradually, and as problems have become apparent research has developed in directions dictated by them.

Early in the conference the trends in supplies of feeding stuffs in the international markets were examined. Supplies of cereals are good and likely to continue to be reasonably plentiful. Supplies of protein concentrates are poor, and likely to remain so. Emphasis was rightly placed on the limitations of current knowledge about the nutritive values or feeding potentialities of many protein-rich plant by-products, it being recognized that scientific knowledge is extensive only so far as soya bean and groundnut meals are concerned.

Emphasis was placed on the contribution that grass and grassland products can make to solving present and future feeding problems. Grass is the most important single crop in Britain, already providing between 65 and 70 per cent of the energy needed by the nation's livestock together with important amounts of protein, while remaining the cheapest source of these nutrients. There remain great opportunities for increase in grass yield per acre on many farms.

It was recognized that mastery over grass production is easier to attain than efficient use of the crop as it grows in the field. The first step towards greater efficiency is the correct combination of strip grazing of properly manured grass (the herd being restrained by electric fencing) with conservation of the excess grass for winter feeding. By full exploitation of grass throughout the year, important quantities of feed, and especially of protein concentrates, can be saved in the dairy herd. These are then available for pigs and poultry.

Difficulties in such intensified management of grass were frankly stated. Most important of all is the effect on farmers and farm workers of the monotonous nature of daily work on a dairy farm based on high grass production. Also, various diseases appear to be closely linked to the feeding of young, highly nutritious grass, although they can be largely controlled by careful management. Again, in some areas, grass is not a reliable crop, whereas in others it offers to farmers a greater security against adverse weather.

In addition to the savings in concentrates that the greater use of grass permits in the milking herd, the prospects of economy in rearing replacements for the herd were also examined. Special attention was given to the results now coming forward from studies of one-egg twin heifers reared on different planes of nutrition. In spite of the slow growth they permit, low planes of rearing have practically no influence on final size at maturity; and although the onset of first œstrus is delayed by about three and a half months, subsequent fertility is not affected. On changing animals from a low plane of rearing to a high plane, there is a rapid increase in growth-rate, and heifers reared on low planes of nutrition gain rapidly in weight during the first lactation. Milk yields of animals reared on low planes of nutrition are somewhat lower in the first lactation, and to a lesser extent in the second. Economy in costly winter feeding can be practised with safety, provided that good summer grazing is available; but if heifers are to be bred in mid-winter to calve the following autumn, it may be necessary to provide a generous winter ration to ensure early fertility.

Economies in the feeding of pigs and poultry were seen as a problem in securing a more efficient use of protein concentrates, and particularly in devising rations that would allow the deflexion of scarce and costly animal by-products to those animals that need them most: to breeding stock and young stock. It is now possible, without using any supplements of the 'animal protein factor', to make rations exclusively from plant sources that will meet all the needs of pigs from 90 lb. live weight to bacon weight and of birds throughout the laying year, provided the eggs are not to be used for hatching. Under British conditions it is much less difficult to meet the needs of these stock for vitamin B_{12} than for riboflavin, widespread deficiency of riboflavin existing in many flocks of breeding birds. Small economies can be made in the use of feeding stuffs in rearing bacon pigs by following a system of restricted feeding; but such savings are made largely at the expense of prolonged rearing times—that is, at the cost of greater labour and overhead charges. Only limited savings of concentrates could be made by the use of herbage in feeding bacon pigs.

Stress was placed on the need for more information about the energy that common feeds can provide for poultry and about many protein concentrates used in practical pig and poultry rations. As a guide to the energy value of feeds, the crude fibre-content is known to be unreliable; but little research is directed to finding analytical methods that will give a better prediction of the amount of energy that non-ruminants can extract from feeds and put to productive use. More active research is developing in the field of assessing the supplementary value of protein-rich concentrates in rations, and this is leading to a better understanding of the nutritive value of traditional protein sources. Less-known products, such as the meat meal, grax and condensed solubles, produced by the Antarctic whaling industry, are under special study, not only to determine the value of existing products but also to aid in the improvement of whale processing on factory ships and at shore stations so that minimal damage is done to this important source of extra protein for pig and poultry feeding.

The stimulation of growth and the savings in feed that are the possible results of fortifying a ration with antibiotics were also discussed. The picture continues to be indistinct. Where a condition exists for an antibiotic to exert a therapeutic effect, a spectacular result will be observed. In carefully controlled experiments small advantages will usually be found. In practical trials on farms the response to antibiotics is extremely variable, but farmers may choose to pay for the safeguard that an antibiotic can give.

The conference concluded with a discussion of the role of the agricultural adviser who links the research worker and the practical farmer. There was frank recognition of difficulties that must continue to face those whose task it is to translate the new findings of research stations into profitable practices on the farms in Britain, where the farming systems are so diversified.

John Duckworth

MIXING OF THICK LIQUIDS, PASTES AND SLURRIES

In a recent report of the Committee on Chemical Engineering Research of the Department of Scientific and Industrial Research, it was pointed out that the general subject of mixing is one which would profit by more fundamental research. Although the mixing of thick materials is a matter of considerable industrial importance, there is virtually no basic information about such mixing problems, and most mixing machines have been designed by intuition and the use of empirical methods. On September 25 the British Society of Rheology organized in London a symposium on the "Mixing of Thick Liquids, Pastes and Slurries", in the hope of collecting what information is available and of clarifying the more important scientific aspects of the subject.

The symposium was opened by Mr. P. V. Danckwerts (Department of Chemical Engineering, University of Cambridge) with a paper on "General Aspects of Mixtures and Mixing". This excellent introduction to the subject first considered how the extent of mixing could be measured quantitatively. For this purpose Mr. Danckwerts introduced the concept of a 'scale of scrutiny', which he applied to the minimum size of the regions of segregation in the mixture which would cause it to be regarded as imperfectly mixed for specific purposes. The goodness of mixing could be characterized by two factors: the 'scale of segregation' is a measure of the size of the regions of segregation, or 'clumps' of the unmixed components, in an imperfect mixture, while the 'intensity of segregation' is a measure of the departure of the composition from the mean value, averaged over all the points in the mixture. Some proposed experiments were described on the mixing of two differently coloured pastes, where the number of intersections per unit length appearing along a cut section of the mixed material would provide a measure of the scale of segregation. For thick pastes the intensity of segregation will be equal to unity.

Mr. Danckwerts then suggested that dimensional analysis could help considerably in simplifying the mathematical approach to mixing problems. For the mixing of two Newtonian liquids of the same viscosity, the intensity of segregation can be expressed as a function of seven variables, but by use of dimensional analysis this can be reduced to four dimensionless groupings of variables. Some of these groupings represent important properties of the state of the system, such as Reynolds, Froude and Schmidt numbers, while others can be given a physical significance such as 'number of clumps'. These concepts may be of considerable use in 'scaling up' results from models to larger mixers. When mixing liquids of unlike viscosities, many more complications are introduced, and for Bingham solids a dimensionless grouping corresponding to a 'stiffness factor' must be introduced.

Mr. E. H. Jones (British Cotton Industry Research Association) next gave a short paper on "The Preparation of Pastes of Starch and Certain Gums for use in Textile Materials". The property of 'weavability' is imparted to textile threads before weaving, by treating with a sizing solution. The amount of size taken up by the threads as they pass through the solution depends largely on the viscosity of the sizing solution, and it is important to keep this constant. The solution contains some clay as a suspension, some tallow as an emulsion and some inorganic salts as a solution, as well as gelatinized starch and gums as a colloidal suspension. At present, an attempt is being made to develop a machine which will apply a fixed weight of solids to the thread, even if the viscosity of the solution should vary.

In the first paper of the afternoon session, on "The Mixing of Wheaten Flour Doughs", Mr. S. J. Cornford (British Baking Industries Research Association) reviewed the literature on this subject and considered how the mixing characteristics of flour doughs can be used to predict the suitability of a flour for bread-making. The effect of mixing on flour doughs depends partly on the atmosphere in which the mixing is carried out, as the mechanical effect is modified by air inclusion and oxidation during mixing. Three factors contribute to the resistance encountered during mixing: mechanical resistance, protein swelling and sticking. The peaks in the mixing curve due to these causes do not necessarily coincide, and it is possible for some agents to affect one peak without affecting the others.

A paper by Mr. D. C. Broome (Limmer and Trinidad Lake Asphalt Co.) was read in his absence by Mr. A. E. Howes. Although mixing of thick materials is such an important technical matter to the asphalt industry, there has been little improvement in its mixing machines during the past half-century. Some progress is now being made, and a continuous mixer for bituminous road-mixes has been introduced in the United States. In Britain an improved type of 'whirlpool mixer' has recently been developed, and this enables mixing to be carried out in a considerably shorter time than with the older types of mixer. An 'impactor' type of mixer has also been reported from Germany.

A paper from the Road Research Laboratory, West Drayton, submitted by Dr. A. R. Lee, was read in three parts by members of the Laboratory staff. Mr. K. E. Clare gave an account of the problems involved in mixing soil and cement when making special types of road. One of the main difficulties is segregation during *in situ* mixing due to the greater density of the cement, resulting in a low concentration of cement at the upper surface of the road.

Mr. F. N. Sparkes discussed the problems caused by the fact that engineers tend to specify concrete mixes which are 'leaner' than formerly. Such mixes

tend to be of much stiffer consistency and result in sticking of the material to the inside of the mixer. The efficiency of the tilting, non-tilting and other types of concrete mixer have been investigated recently at the Road Research Laboratory by a sampling procedure, and it has been shown how the mixer can be modified so as greatly to reduce this difficulty.

Dr. R. S. Millard gave an account of the difficulties involved in sampling bituminous mixes used for road construction. A special sectionalized frame has been made for taking samples from a mixer, and it has been shown that quite large variations in bitumen content are to be expected from some types of mixer which are in use at present.

The last paper, by Mr. K. A. Lammiman (Research Council, British Whiting Federation), was on "The Mixing of Linseed Oil Putty". A description was given of the present methods of making putty on a commercial scale, and of the difficulties of measuring oil absorptions for different samples of whiting. The extension before break is an important attribute of the mixed putty, and an extensometer has been constructed to measure this property more accurately than the operative's method of stretching between the hands. Considerable work has been done on the measurement of the density of the material under different conditions of mixing.

The symposium showed that industry is at least aware of the need for attacking mixing problems on a scientific basis. Further progress is to be expected when the methods described by Mr. Danckwerts are applied to the many practical mixing problems described by the other speakers. N. WOOKEY

RESEARCH STATION OF THE PARSONS AND MARINE ENGINEERING TURBINE RESEARCH AND DEVELOPMENT ASSOCIATION

AT the open day of the Research Station of the Parsons and Marine Engineering Turbine Research and Development Association (Pametrada), held on October 5, it was noteworthy that the three and a half years which have elapsed since the Station was last open for viewing have marked a period of considerable expansion as well as the consolidation to be expected after the rapid growth of its first five years. The period also covers the running for rather more than a thousand hours of the 3,500 s.h.p. marine gas-turbine, which was first set in motion in April 1950. The chairman of the Association, Sir Philip Johnson, pointed out in his welcoming address that this installation is a realistic one, small enough, cheap enough and efficient enough to compete economically with other forms of ship propulsion, and with a sufficient life and reliability to be acceptable for marine service. This is not to say, of course, that there have been none of the teething troubles from which is acquired that valuable experience or 'know how'; but the lines of further development are clear ahead to the extent that the Association is now, in conjunction as usual with its member firms, in a position to produce designs for ships' gas-turbine sets which will be capable of providing the sole propulsion machinery on a satisfactory basis of economy and reliability.

The natural attention attracted by this large, impressive and advanced piece of development tended to overshadow the important and interesting exhibits in other parts of the laboratories, almost all of which were on show to the visitor. Work continues on research and development in connexion with steam turbines: there was on show a six-stage impulse machine known as 'Pamela', designed to provide experience with steam at high temperature and high pressure simultaneously, the maximum conditions being 1,100 lb./in.^{2} and 1,100° F. (about 600° C.), and there continue to be full-scale trials run on propulsion machinery as a whole, including the turbines and their associated reduction gearing.

A considerable amount of work is going on in connexion with the development of marine reduction gearing and on long-term research into gearing problems. No less than three back-to-back rigs are employed for full-scale work on marine gear units, and in this connexion the Association has developed an ingenious hydraulic device which can be used as a torque loader and torque meter. One of the most interesting exhibits in the gearing section was that which illustrated the effect of helix correction on the life of marine turbine gearing. As is well known, marine turbine pinions have a large length/diameter ratio, and the deflexions on them due to bending, shear and torque are, in sum, considerable. By suitable adjustment of the lead of the two pinion helices with respect to those of the mating wheel, the unit can be made to transmit full load with even loading across the full face-width after taking into account the full deflexions.

Rigs for studying journal bearings, turbine blade vibrations, etc., were also to be seen in the main laboratories. It is particularly noteworthy that the work on bearings has led to the clear establishment of an optimum length/diameter ratio between 1/3 and 2/3. In the small-scale mechanical laboratory were three disk machines of the Amsler, Niemann and Timken types for investigations into gear materials and into problems of gear tooth lubrication, while in the applied science laboratories could be seen further long-term researches into these subjects.

The development work on combustion of fuels for gas turbines and the associated problems of fouling and corrosion were displayed in a series of interesting exhibits in the combustion laboratory. It appears that very considerable progress has been made towards solving the problems of combustion of low-grade fuels in marine gas-turbine installations.

Also as part of the combustion work a considerable number of investigations has been made into problems of oil-fuel spraying. It is particularly interesting to see the relatively large scale of the oil-fuel sprayers developed for the gas-turbine installations as compared with the familiar type for compression-ignition engines. The importance in the latter of equal fuel delivered to each cylinder is also paralleled by the need to ensure that multiple combustion chambers give substantially equal outputs per chamber if there are not to be wide variations of inlet temperature around the turbine. Here two developments are continuing in parallel, by improving the sprayers themselves and by the experimental use of a mixing chamber between the flame tubes and the turbine proper. Furthermore, the importance of being able to effect easy replacement of injectors in the com-

bustion-ignition engine to maintain it in efficient service is again paralleled by the development of replaceable sprayers, which, however, have to solve the more difficult problem of replacement without shutting down the main plant.

In the aerodynamics laboratory was an interesting single-stage air turbine. The laboratory already has substantial facilities for aerodynamic work, particularly on turbine blading; but these are to be extended still further when the high-speed variable-density cascade tunnel, which has been designed to enable independent control of the Mach and Reynolds numbers, is installed.

A considerable amount of development in measurement of noise was evidenced by the equipment on view both in the applied science and in the small mechanical laboratories. Those who have experienced the unpleasant sensations which can be associated with the noise from a blower will be grateful for the development of acoustic filters which, although simple in design, were shown to reduce an almost intolerable noise to within the limits of comparative comfort.

The work at the Research Station has led to the development of a very considerable amount of ingenious and effective measuring equipment. Particular reference should perhaps be made to the wave analyser which is now being marketed commercially in the name of 'Muirhead–Pametrada'. The progress in dealing with the problem of noise and vibrations generally is striking.

The strides that have been made by the Association in the eight years since its foundation reflect immense credit on it and its staff, particularly the research director, Dr. T. W. F. Brown. One of the most important factors contributing to its achievement must undoubtedly be that the Station is closely associated with the commercial success of its designs, so that although the work is frequently of a fundamental nature or indeed concerned with the development of equipment to measure the variables in a fundamental investigation, there is in the last event the acid test of whether the designs will work in a ship's installation to keep the feet of the staff firmly on the ground. During the six years since the first turbine designed at the Station went into service, more than fifty sets have been installed and are in satisfactory operation.

GEORGE E. DAVIS (1850–1907) AND CHEMICAL ENGINEERING

A MEETING was held in Manchester on October 10, under the auspices of the Institution of Chemical Engineers and the Society of Chemical Industry, to commemorate George E. Davis, who is recognized throughout the English-speaking world as the pioneer of chemical engineering. The principal feature of the meeting was a Memorial Lecture given at the College of Technology by Mr. Norman Swindin, who was closely associated with Davis during 1900–7.

George Edward Davis was born at Eton in 1850 and studied chemistry at the Slough Mechanics Institute and the Royal School of Mines, London. After a period spent in obtaining industrial experience in a variety of chemical works, Davis set up in private practice, as what would now be called a consulting chemical engineer, in Manchester in 1880. Very soon after this, however, he became an alkali inspector and did not return to his private practice until 1884. The remaining twenty-three years of his life he devoted mainly to his practice and to editing *The Chemical Trade Journal*, which he founded in 1887 and which still flourishes.

Davis made major contributions to two important industrial processes. His first love was the gas industry, and when he was only eighteen he began research on the extraction of benzene from coal gas; this side of his work culminated in the erection of a by-product plant at Rockingham which was technically ahead of its time and was not superseded until after his death. He also made great contributions to the Leblanc soda process and the allied Weldon process for the manufacture of chlorine. He himself devised a process for the production of chlorine by the oxidation of hydrochloric acid by nitric acid; this was not a commercial success, largely for the same reasons, technical and economic, which were leading at this time to the rapid decline of the once all-important Leblanc process. In all his work, doubtless owing to his experience as an alkali inspector, Davis scrupulously avoided waste and its accompanying nuisances of smoke, noxious fumes and river pollution.

His wide industrial experience brought home to Davis the fact that many promising laboratory processes failed to come to industrial fruition, not because of any chemical defects, but solely owing to the lack of men possessing the skill and knowledge necessary for the erection of adequate plant. The lack of such persons "possessing a knowledge of chemistry, physics and mechanics and who employed their knowledge for the utilization of chemical reactions on the large scale" he strove to set right by delivering, in 1887, a course of lectures on chemical engineering (the first lectures in the world on the subject) at the old Manchester Technical School, now the Manchester College of Technology; he collected these lectures together, in an expanded form, in his two-volume "Handbook of Chemical Engineering", which was published in Manchester in 1901 and was the first text-book on this subject. The seed which Davis sowed in 1887 has flourished, and the vital importance of chemical engineering is now universally recognized.

Mr. Norman Swindin's excellent Memorial Lecture will be published by the Institution of Chemical Engineers and should, and no doubt will, be read by every chemical engineer and student of chemical engineering. Something more than this, however, seems necessary as a memorial to a man who, it is increasingly being realized, was one of the true pioneers of the modern world. In his lecture Mr. Swindin said that Davis strongly advocated the foundation of chairs of chemical engineering and held that the Manchester College of Technology was the ideal training-ground for industrial chemists of all kinds; the College, for its part, has always insisted on adequate engineering training for all its chemical students and was the first in England to institute a bachelor's degree in chemical engineering. Chemical industry throughout the world owes much to Davis; it could find no better way of recognizing, and in part repaying, this debt than by adequately endowing, as a memorial to him, the school of chemical engineering in the institution in which he founded the subject and which he admired so much.

H. N. Rydon

CLASSICAL CONSIDERATIONS ON THE ABNORMAL PROPERTIES OF HELIUM-4

By S. F. B. TYABJI

Christ's College, Cambridge

IN the course of work on a quantum theory for liquids in the Lagrange variables (which will be published elsewhere), it began to appear that many of the abnormal properties of helium-4 are explained by classical theory alone, provided three assumptions are made.

(1) The internal energy of helium can be expressed in the classical form $W = \int \frac{p}{\rho^2} d\rho$, the functional relationship between p and ρ to be determined by experiment.

(2) At low temperatures the heat energy in helium-4 consists mainly of longitudinal waves, 'phonons', of wave-lengths comparable to the diameters of the fine capillaries and thin slits in which superfluidity has been observed, and therefore of wave-lengths long compared to molecular distances. This assumption has already been made by Landau in his treatment of the liquid as a continuous medium.

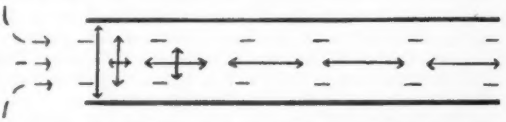
(3) Viscosity in helium-4 consists of the change in momentum in one layer of a laminar flow by reason of particles of liquid from an adjacent layer, travelling with a different velocity, passing into the first layer as a result of thermal agitation. Helium-4 is thus regarded as a 'gas-like' liquid[1]. This accords with the experimental fact that the viscosity *falls* with the temperature even before the λ-point.

We may, consistently with the second hypothesis, assume that the velocity field of the thermal agitation has a potential φ. Since there must be no transport of fluid by the thermal agitation alone, $\overline{\frac{\partial \varphi}{\partial x_k}}$ $(k = 1, 2, 3)$ must vanish over any macroscopic region; the bar indicates a mean value. The second hypothesis also requires that $\partial\varphi/\partial x_k$ must vanish everywhere with the temperature, T. φ is, therefore, a function of x_1, x_2, x_3, t, T. The second hypothesis now enables the coefficient of viscosity μ to be written:

$$\mu = \rho \overline{\left(\frac{\partial \varphi}{\partial x_3}\right)^2}. \qquad (1)$$

The average, here, is to be taken over a unit area perpendicular to the gradient of the laminar flow $\bar{v}$. This gradient is assumed to be in the x_3 direction. The thermal velocity with the velocity potential φ is to be thought of as superposed on the laminar flow $\bar{v}$.

Relation (1) shows that the viscosity must vanish if φ becomes independent of x_3. It can be rigorously shown that such a thermal agitation introduced into a capillary which has its axis parallel, say, to the x_1 axes, or between disks parallel to the x_1, x_2 plane, becomes independent of x_3 exponentially with the distance along the capillary or disk, provided that the wave-length of the thermal disturbance is greater than 1·706 times the width of the capillary (and probably a comparable quantity in the case of a slit). Thus in a capillary of diameter $\approx 0{\cdot}01$ cm., viscosity must practically disappear after a distance of $\approx 0{\cdot}01$ cm. This result may be pictured as follows. When helium is in an ordinary container, the heat vibrations are in all directions, and those that are not parallel to the laminar flow cause the viscosity. If, however, the helium flows through a capillary with rigid sides, the heat vibrations become parallel to the sides, that is, to the laminar flow, and, therefore, viscosity disappears. Since no such effect can take place when viscosity is measured with an oscillating disk, that method gives a normal value for the viscosity. In the accompanying diagram, the $\partial\varphi/\partial x_3$ component of the thermal velocity is shown becoming parallel to the laminar flow.



A number of other abnormal phenomena in helium can be explained on this model. Thus pressure measurements of the type made by Bowers and Mendelssohn[2], which showed that the fall of pressure was almost entirely at the end at which the helium entered the capillary, is now explained, because the viscosity would disappear after, but only after, the helium had travelled a short distance into the capillary. Hence the pressure is utilized for moving the helium through the first short distance, and the flow then becomes independent of the pressure. Similarly the 'fountain effect' and thermal flow find a natural explanation. It can be shown that plane waves transport fluid, and since the thermal agitation becomes plane waves after the helium enters the capillary or slit, both the fountain effect and the 'reverse fountain effect', first observed by Allen and Reekie[3], are explained. The fact that superfluidity breaks down at high velocities, depending on the diameter of the capillary and the temperature, becomes understandable. At higher velocities more and more of the liquid which has not had its viscosity removed by the action of the sides enters the capillary, thus choking it more and more, until free flow can no longer take place. Kapitza had observed that helium that had come through a slit emerged cooler than the temperature at which it had entered[4]. It is clear that this must be so. For the thermal agitation, which before the helium entered the slit was in arbitrary directions, is made parallel to the sides by their action. If the sides were mathematically rigid, energy would be conserved in the liquid, and the temperature on emergence could be expected to be the same as on entrance. But since the sides are, in fact, not absolutely rigid, some of the heat in the helium is taken up by the sides and the temperature of the emerging fluid is accordingly lower.

'Second sound' follows from the second hypothesis. Conversely, the second hypothesis is required by the experimental fact that, at low temperatures, propagation of heat obeys a wave equation and not the equation of heat diffusion. In the picture now postulated, 'second sound' is a group of waves and its velocity is the group velocity. It can be shown that the group velocity must be $\sim$ (specific heat)$^{-1}$ [2], in agreement with experiment. This relationship between the velocity of second sound and the specific heat is confirmed by other experimental evidence: though both the velocity and the specific heat change on alteration of the external pressure, the change is such as to keep the relationship intact.

Helium-3 does not exhibit superfluidity. But though helium-3 and helium-4 are isotopes and chemically indistinguishable, physically they are very

different. First of all, helium-3 is a 'solid-like' liquid; its viscosity *rises* with lowering temperature. Hence the formula (1) for the viscosity and the third hypothesis on which it is based do not hold for helium-3. On the contrary, the viscosity of helium-3 would be represented by the formula[1]:

$$\mu = A \exp(W/kT), \qquad (2)$$

where A is approximately a constant and $\exp(W/kT)$ is proportional to the self-diffusion coefficient. Therefore, none of the considerations used for explaining the abnormal properties of helium-4 can apply to helium-3. In fact, most of the physical characteristics of the two isotopes are different. The vapour pressure of helium-3 is much higher and the density much lower. The density continues to rise to the lowest temperature, whereas that of helium-4 rises until the λ-point is reached and then begins to fall. With atoms of this size one would expect that the physical properties of the liquid would be governed more by the differences of nuclear size and structure than by the similarity of the number of electrons in the atom.

A purely classical theory also seems capable of explaining the cause and the shape of the λ-point, depending again upon the functional relationship between p and ρ. This is done by taking into account terms of higher order than the quadratic in the Lagrangian for the fluid and then obtaining the equations of motion by the variational method.

A rigorous determination of this functional relationship is, clearly, beyond the scope of classical theory, which can only do it empirically. The proper approach to that problem must be by a method similar to that of Born and Green, who start from fundamental assumptions as to the nature of a fluid and of the intermolecular forces. It is satisfactory that, according to their theory, T_λ turns out to be 2·28° K., very close to the observed λ-point, though their theory may require extension and modification.

A fuller discussion and the mathematical proofs will be published elsewhere.

Finally, I must thank Prof. P. A. M. Dirac and Mr. H. N. V. Temperley for valuable criticism.

[June 15.

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SELF-REVERSAL OF THERMO-REMANENT MAGNETIZATION OF IGNEOUS ROCKS

By Prof. TAKESI NAGATA

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In two previous communications[1] the discovery of the phenomenon of self-reversal of thermo-remanent magnetization of igneous rocks was reported. A possible mechanism of this self-reversal of magnetization was discussed, based upon experimental data from measurements of the magnetic properties of the dacitic pumice of Mount Haruna. Since then, various investigators[2] have made an experimental examination of the characteristics of the thermo-remanent magnetization of a number of igneous rocks which show the reverse natural remanent magnetization *in situ*.

My collaborators and I have also extended this work by a similar examination of many other rocks which are reversely magnetized in the field. However, the results of all these experiments show that, with one exception, the reversely magnetized rocks have a normal thermo-remanent magnetization when cooled in a weak magnetic field; the exception is a dacitic pitchstone at Mount Asio in Japan. It would seem, therefore, that the presence of rocks which are capable of self-reversal of thermo-remanent magnetization in laboratory experiments is a rather rare phenomenon, although a fairly large number of examples of reverse natural remanent magnetization of rocks has been discovered at various localities throughout the world.

Nevertheless, I believe that a detailed examination of the magnetic and crystallographic characteristics of those rocks possessing self-reversal of thermo-remanent magnetization will suggest a physical basis for further studies of the reversal of rock magnetism. Experiments were carried out with the ferromagnetic minerals separated from both the Haruna and Asio rock samples. These minerals have a grain size of mean diameter 0·1–0·5 mm. Since the magnetic and crystallographic structures of the ferromagnetic constituents of both these rock types are similar, details for the Haruna rocks only will be given in the following results.

The ferromagnetic mineral grains in the Haruna rocks can be separated magnetically into three groups, namely, those grains which have a Curie point between 500° and 530° C., which are called the A-constituent, those grains having a Curie point below 300° C., which are called B-constituent, and those grains which are composed of both types of crystal and called AB. The percentage of the A- and B-constituents within the AB-grains varies over a wide range.

Results of measurements of the change in saturation magnetization (J_s) of the A-, B- and typical AB-grains have already been reported[3], and are reproduced here as Fig. 1. In this work it was shown directly that the AB-grains are composed of A- and B-constituents; the AB-grains, which have originally a grain size of 0·1–0·5 mm., were pulverized into smaller particles and their magnetic properties examined. When their grain size is reduced to

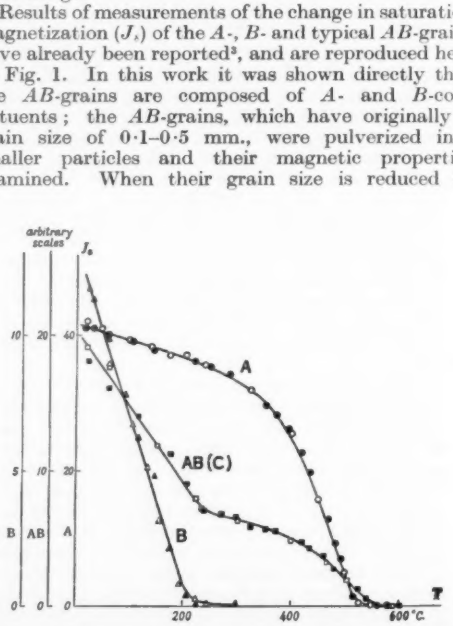

Fig. 1. Curve A, ●, heating process; ○, cooling process. $AB(C)$, ■, heating process; □, cooling process. B, ▲, heating process; △, cooling process

3–5 μ or less, they could be completely separated into two groups. One group has a Curie point between 500° and 530° C., and the other between 200° and 250° C. These two groups correspond with the A- and B-constituents, respectively. AB-grains which contain A- and B-constituents in a ratio of approximately 6 : 1 predominate.

As mentioned previously[3], both the A- and B-grains show normal thermo-remanent magnetization, and only the AB-type can give reverse thermo-remanent magnetization by cooling in a weak magnetic field. Even a single grain of AB can possess reverse thermo-remanent magnetization, whereas a mixture of the A- and B-grains does not show it. It is concluded, therefore, that a strong magnetic interaction among the A- and B-constituents which are contained in each single AB-grain alone is responsible for the appearance of reverse thermo-remanent magnetization.

Thus, Néel's two-phase theory[4] seems to be the preferred explanation of the reverse thermo-remanent magnetization of Haruna and Asio rocks, as long as we assume the effect of magnetic interaction of two constituents only within each single grain of composition AB. Assume now that the orientation of the magnetic domains of the A- and B-constituents are fixed along the effective magnetic field at T_A and T_B, respectively, where $T_A > T_B$. If we cool down the AB-grains from a temperature higher than T_A in a weak magnetic field H, the intensity of magnetization $J(T)$ at a temperature between T_A and T_B ($T_A > T > T_B$) will be given by :

$$J(T) = J_r(T) + J_i^A(T), \qquad (1)$$

where $J_r(T)$ denotes the magnetization reversible with respect to H, and $J_i^A(T)$ is the irreversible magnetization of the A-constituent, being represented by :

$$J_i^A(T) = n_A v_A \sigma_A(T), \qquad (2)$$

where n_A, v_A and $\sigma_A(T)$ are the number of domains in the A-constituents fixed at T_A, their mean volume and intensity of spontaneous magnetization, respectively. Obviously the direction of $J_i^A(T)$ as well as that of $J_r(T)$ will be parallel to the direction of H.

At T_B, where the B-constituent also becomes ferromagnetic, the effective magnetic field, $H_{\text{eff.}}$, for the B-constituent will be given by :

$$H_{\text{eff.}} = H - \{\alpha J_r(T_B) + \beta J_i^A(T_B) + \gamma J_i^B(T_B)\}, \qquad (3)$$

where α, β and γ denote coefficients representing the contributions of the three different kinds of magnetization to the demagnetizing field. They are subject to the shape of the boundaries of those three phases and their geometrical relation to one another. If $H_{\text{eff.}} < 0$ at $T = T_B$, the direction of $J_i^B(T_i)$ is opposite to that of H, and, consequently, to that of $J_i^A(T_B)$. Thus the irreversible magnetization $J_i(T)$ at temperatures below T_B will be represented by

$$J_i(T) = J_i^A(T) + J_i^B(T) = n_A v_A \sigma_A(T) - n_B v_B \sigma_B(T), \qquad (4)$$

where $T < T_B$ and n_B, v_B and $\sigma_B(T)$ are the quantities for the B-constituent corresponding to n_A, v_A and $\sigma_A(T)$ for the A-constituent.

Then, if

$$\frac{n_A v_A}{n_B v_B} < \frac{\sigma_B(T_0)}{\sigma_A(T_0)}, \quad (T_0 < T_B) \qquad (5)$$

at $T = T_0$, the remanent irreversible magnetization

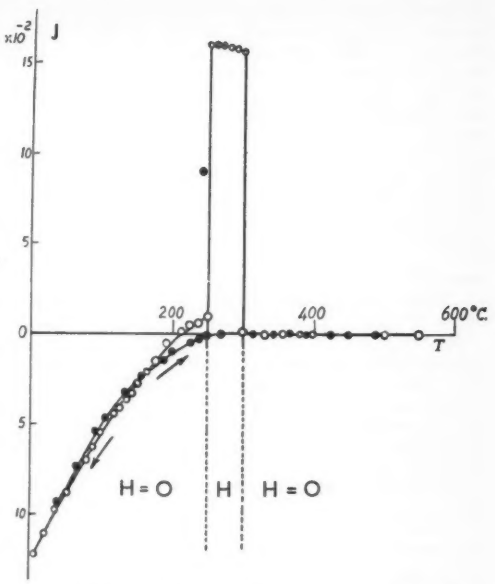

Fig. 2. Development of reversed transverse remanent magnetization with decrease of temperature and its disappearance with increase of temperature. Magnetic field (H = 0·5 Oe.) is applied only during evolving from 300° to 250° C. Haruna magnetic minerals

$J_i(T)$ at $T = T_0$ becomes reversed. Hence the necessary two conditions for getting reverse thermo-remanent magnetization at a comparatively low temperature T_0, say, atmospheric temperature, are given by equation (5) and $H_{\text{eff.}} < 0$ at $T = T_B$.

Since T_B is near the Curie point of the B-constituent, $\sigma_B(T_B) \ll \sigma_A(T_B)$, and since $n_B v_B \lesssim n_A v_A$ according to actual measurements, we get :

$$J_i^A(T_B) = n_A v_A \sigma_A(T_B) \gg J_i^B(T_B) = n_B v_B \sigma_B(T_B). \qquad (6)$$

From equations (5) and (6) the necessary condition for reverse thermo-remanent magnetization at $T = T_0$ is expressed as :

$$\frac{\sigma_B(T_0) - \sigma_B(T_B)}{\sigma_A(T_0) - \sigma_A(T_B)} > \frac{n_A v_A}{n_B v_B}. \qquad (7)$$

In the case of the AB-grains of Haruna rock, $n_A v_A$ is about six times as large as $n_B v_B$. Hence the reversed thermo-remanent magnetization effect can be obtained in this case provided that $\sigma_B(T_0) - \sigma_B(T_B)$ exceeds six times $\sigma_A(T_0) - \sigma_A(T_B)$. As will be seen in Fig. 1, the temperature coefficient of σ_B is markedly larger than that of σ_A. Hence the condition given by equation (7) is fulfilled.

Fig. 2 illustrates an example of the development and decay of partial thermo-remanent magnetization with increase and decrease of temperature respectively. The magnetic field affecting the ferromagnetic mineral groups of the Haruna rocks in the cooling process from 600° C. is kept at zero down to 300° C., and at 0·5 Oe. from 300° C. to 250° C. A positive normal magnetization takes place within this range of temperature chiefly due to reversible magnetization. When the magnetic field is removed at 250° C., there remains a positive remanent magnetization, which decreases with decrease in temperature in the non-magnetic space, becoming reversed below about 200° C. Since the temperature coefficient of this

reversed thermo-remanent magnetization is almost constant and large, it will be clear that it is chiefly due to the magnetization of the *B*-constituent[5]. The change of the reversed thermo-remanent magnetization with temperature in the furnace on re-heating in a non-magnetic space is in fairly good agreement with that found in the cooling process, so long as the temperature does not exceed 200° C. It must be noticed that the reversed magnetization in this re-heating process never takes a positive value. This fact may indicate that the reversible magnetization $J_r(T)$ in equation (3) takes an important role in giving a negative value of H_{eff}.

The problem of self-reversal of thermo-remanent magnetization can be reduced to the following two main points: What are the magnetic and crystal structures of the *A*- and *B*-constituents? And how have these two interacted with each other within the *AB*-grains? In order to investigate the first question, chemical and *X*-ray analyses were carried out. Results for the chemical analysis of Haruna rock are shown in Table 1.

Table 1

Constituent	For all grains	For *A* grains	For *B* grains
Fe_2O_3	57·9 per cent	58·7 per cent	43·5 per cent
FeO	34·7 ,,	34·2 ,,	24·2 ,,
TiO_2	7·4 ,,	7·0 ,,	32·3 ,,

All percentages are by weight

The chemical compositions of the *A*- and *B*-grains are plotted on the diagram of the ternary system of Fe_2O_3—FeO—TiO_2 in molecular percentages in Fig. 3. These results indicate that the *A*-constituent is a titanomagnetite the Curie point of which must be a little less than that of pure magnetite (575° C.), while the chemical composition of the *B*-constituent is nearly on the line connecting ilmenite and hæmatite.

The ratio of *A* to *B* in all the ferromagnetic minerals is estimated to be about 70 : 1 from the chemical analyses given in Table 1, and this value is nearly in accord with the results of the magnetic separation. On the other hand, the X-ray analysis of the *A*-, *B*- and *AB*-grains gave the results shown in Table 2, in which are shown the lattice constants of nearly stoichiometric magnetite and ilmenite for comparison.

The lattice constant and the crystal structure of the *A*-constituent are nearly the same as those of magnetite, while the crystal structure of the *B*-constituent is clearly rhombohedral, with the lattice parameters a little shifted away from those of pure ilmenite towards hæmatite. These results are, then, in good agreement with the chemical analyses.

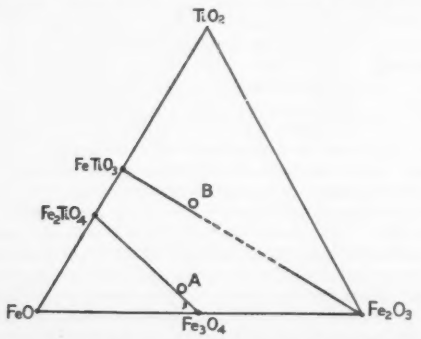

Fig. 3. Chemical composition of the *A*- and *B*-constituents of ferromagnetic minerals of Haruna rocks. Full lines show possible ranges of solid solution (after Pouillard, ref. 6)

Table 2

Source	Grain	Crystal structure	Lattice constant
Haruna	*A*	Cubic (inverse spinel)	$a = 8{\cdot}403 \pm 0{\cdot}003$ A.
	B	Rhombohedral	$a_{rh} = 5{\cdot}480 \pm 0{\cdot}002$ A. $\alpha = 55° 08' \pm 1'$
	AB	*A* + *B*	$a = 8{\cdot}401$ A., $a_{rh} = 5{\cdot}473$ A.
Asio	*A*	Cubic (inverse spinel)	$a = 8{\cdot}397 \pm 0{\cdot}004$ A.
	B	Rhombohedral	$a_{rh} = 5{\cdot}483 \pm 0{\cdot}004$ A. $\alpha = 55° 01' \pm 3'$
	AB	*A* + *B*	$a = 8{\cdot}40$ A., $a_{rh} = 5{\cdot}48$ A.
Magnetite		Cubic (inverse spinel)	$a = 8{\cdot}397 \pm 0{\cdot}003$ A.
Ilmenite		Rhombohedral	$a_{rh} = 5{\cdot}540 \pm 0{\cdot}002$ A. $\alpha = 54° 44' \pm 2'$

The X-ray spectra of the *AB*-grains showed, both for Haruna and Asio rocks, just a superposition of those of the *A*- and *B*-constituents. Here again we have evidence that the *AB*-grain is a mixture of the *A*- and *B*-constituents.

One of the remaining difficulties is why the *B*-constituent, which has a rhombohedral structure close to that of ilmenite, is so strongly ferromagnetic. The saturation magnetization σ_B of this constituent increases linearly with decrease in temperature down to the temperature of boiling liquid air, according to our measurements. Néel[7] has also shown that σ_B increases almost linearly with decrease in temperature down to about 1° K. This result may suggest that the *B*-constituent is one of Néel's ferrimagnetics. The magnetic properties of the *B*-constituent seem to present a new problem in crystal physics.

So far as the majority of reversely magnetized rocks are concerned, the above mechanism of self-reversal of thermo-remanent magnetization may not be responsible for the phenomenon observed, because the presence of such a peculiar mineral as the *B*-constituent seems to be quite rare. According to our experiments, however, the ferromagnetic minerals in rocks very generally consist of various compositions of differing Curie points and they interact magnetically with each other. While the magnetization of some compositions is reversed, this reversed component is not as strong as in the Asio and Haruna rocks. If the magnetization of any normally magnetized part disappeared or was diminished due to some chemical or physical alteration during a long period of time, and the reversed part were comparatively stable, the resultant magnetization might be reversed. Therefore, one cannot yet abandon as an alternative the possibility of some form of self-reversal in rock magnetism generally. Experimental examination of reversely magnetized rocks with this as a working hypothesis is now proceeding.

The experimental investigations mentioned in this article have been carried out with S. Akimoto and S. Uyeda and with the co-operation of Prof. L. Néel. My thanks are due to Profs. P. M. S. Blackett and E. Thellier, Drs. J. A. Clegg and H. Manley, Mr. J. Hospers and others for valuable discussions.

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LETTERS TO THE EDITORS

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Radio-Frequency Radiation from the Spiral Nebula Messier 81

FOLLOWING the detection[1] of radio-frequency radiation from the Great Nebula in Andromeda *M*.31, the 218-ft. paraboloid at the Jodrell Bank Experimental Station has been used for continuing the observations of extra-galactic nebulæ, and the preliminary results have already been published[2]. The survey has recently been extended to the region of sky around the bright *Sb*-type spiral nebula *M*.81, which is of particular interest since a previous survey[3] failed to detect the radiation from this nebula, which is one of the brightest in the sky, although in the same survey fainter nebulæ were observed. Fig. 1 is a record of the power received with the aerial beam directed to declination N. 69°, and shows a radio source superimposed on a gradient of the background radiation. The co-ordinates and intensity of this source, together with those of the nebula, are given in Table 1, and in view of the close agreement of the co-ordinates, the source may be provisionally identified with the nebula.

As the source is so clearly resolved, and as its apparent angular diameter is small compared with the width of the aerial beam (2° between half-power points), the observation probably represents the most reliable measurement at present available of the intensity of the radiation from a late-type spiral nebula.

The measurement of the radio intensity from *M*.81 has been combined with the previous observations[2,5] to determine the ratio between the radio flux and light flux for individual nebulæ. A previous suggestion that the apparent photographic magnitude increases more rapidly than the apparent radio magnitude was largely based on the value of intensity for a faint nebula ($Mpg = +16{\cdot}0$) which was derived from a cluster in Perseus. However, it has since been pointed out by Minkowski (private communication) that the Perseus cluster contains a peculiar nebula *NGC* 1275 which apparently consists of two nebulæ in collision. This object may be an abnormal radio emitter, and therefore its inclusion in the analysis was invalid. The present result, together with the previous results[5] on individual nebulæ, are consistent with a constant ratio between the total light flux and radio flux from late-type spiral nebulæ, and show that the intensity from a nebula of apparent magnitude + 10 (Shapley–Ames) is approximately $4{\cdot}2 \times 10^{-26}$ watts/sq. m./c.p.s. at 158·5 Mc./s. The variations which have been observed in the difference between the apparent radio and photographic magnitudes are of the order of 0·5 magnitude, and are probably due either to the effects of visual obscuration corresponding to the varying galactic latitudes and orientations of the nebulæ, or (as in the case of *M*.31) to errors in the integration of the observed flux over the nebulæ.

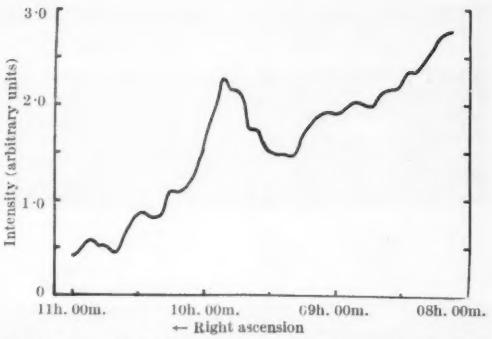

Fig. 1. A record of the transit of the radio source associated with *M*.81, taken with the aerial beam directed to declination N. 69°. Ordinates: intensity in arbitrary units; abscissæ: hours of Right Ascension

Table 1. DATA ON RADIO SOURCE AND *M*.81 EPOCH 1950

	R.A.	Declination	Intensity* at 158·5 Mc./s. W./sq. m./c.p.s.	Apparent photographic magnitude
Radio source	09h. 51m. 20s. ± 2m.	N. 69° ± 1°	12×10^{-26} ± 20 per cent	—
Messier 81	09h. 51m. 30s.	N. 69° 18′	—	+ 8·9 (ref. 4)

* The intensity given is twice that observed in one plane of polarization.

The work has been carried out at the Jodrell Bank Experimental Station of the University of Manchester. We wish to thank Prof. A. C. B. Lovell for his interest in the investigation. One of us (R. H. B.) is indebted to Imperial Chemical Industries, Ltd., for a research fellowship.

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Cheshire. Oct. 2.

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The Typical Perseid Meteor Spectrum

THE first Perseid meteor spectrum was photographed by S. Blajko at Moscow on a blue-sensitive plate on August 12, 1904 [1,2]; but up to 1934 only two additional examples of such photographs had been secured. The emission lines of Fe I, Ca I, Ca II, Mg I, Mn I and Al I were identified in the early photographic spectra, the *H* and *K* lines of Ca II generally being the strongest feature.

In various programmes of meteor photography I have carried out at the David Dunlap Observatory and at the Dominion Observatory in the period 1934–53, some twenty-five Perseid spectra have been secured. Faint records on panchromatic plates were first obtained in 1934 [3], and the lines of Na I in the yellow and Si II in the red were tentatively identified. This identification was confirmed by better spectra secured in 1939 and 1940 [4]. More recently, through the use of replica transmission gratings, spectra showing considerably better resolution in the red have been photographed at the Dominion Observatory[5]. In particular, spectrum No. 126, obtained on August 12, 1952, showed a detail of more than a hundred bright lines. Lines of hydrogen and of Fe II, which had been suspected in earlier spectra, were definitely identified in this meteor. In the 1950 observations two faint spectra were

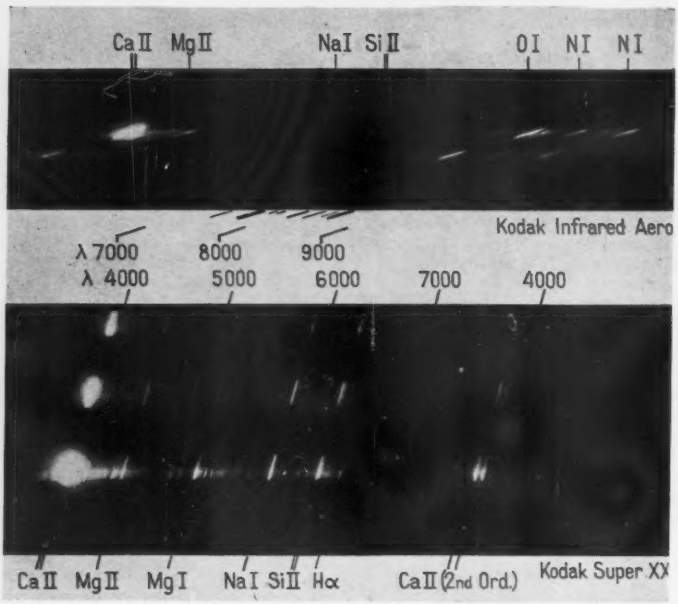

Fig. 1. Perseid meteor spectra, photographed at the Dominion Observatory, Ottawa, in August 1953

photographed on Kodak Aero Infra-red emulsion and the O I lines at 7774 A. were found. An infra-red spectrum with considerably more detail was photographed at Ottawa on August 14, 1953, and the brightest lines in the range 7000–9000 A. have been satisfactorily identified as due to O I and N I, confirming all the faint features in the 1950 infra-red spectra. The 1953 infra-red spectrum is reproduced herewith.

As noted some years ago[6], all Perseid spectra are remarkably similar and seem to show the same general features within the limitations of photographic resolution and emulsion sensitivity. In the accompanying table the multiplets that have been identified in Perseid spectra are listed, the numbers in brackets corresponding to those used in Dr. C. E. Moore's multiplet table[7]. Doubtful identifications have been omitted. The table contains seventy-two multiplets of ten neutral atoms and four ionized atoms. These multiplets may be considered a normal feature of the light of bright Perseid meteors in the wave-length range 3500–9000 A.

Multiplets in Perseid Meteor Spectra

H	(1)	Mg I	(23)	Ca I	(3)	Fe I	(20)
					(4)		(21)
N I	(1)	Mg II	(4)		(18)		(23)
	(2)				(19)		(41)
	(3)	Al I	(1)		(20)		(42)
	(16)		(5)		(21)		(43)
	(20)				(23)		(152)
	(25)	Si I	(2)		(47)		(168)
			(3)		(49)		(268)
O I	(1)		(9)				(318)
	(4)		(10)	Ca II	(1)		
			(11)		(2)	Fe II	(27)
Na I	(1)		(16)				(28)
	(5)			Mn I	(2)		(37)
	(6)	Si II	(1)				(38)
			(2)	Fe I	(1)		(42)
Mg I	(1)		(3)		(2)		(48)
	(2)		(4)		(3)		(49)
	(3)		(5)		(4)		(74)
	(9)				(5)		
	(11)	Ca I	(1)		(15)		
	(14)		(2)		(16)		

The $H\alpha$ line appears quite definitely and is of moderate strength. Its presence seems to lend support to Whipple's comet model[8], which suggests large quantities of hydrogen ices in the original particles making up a comet nucleus. Some of these hydrogen ices might well be retained in meteoritic particles large enough to produce a Perseid fireball in the visual magnitude range covered by these spectra, namely, -2 to -7. (*Note added in proof.* Dr. G. P. Kuiper has suggested to me the additional possibility of the hydrogen occurring in the water of crystallization of certain compounds possibly present in cometary meteoroids.)

Two spectra photographed in 1952 with a rotating shutter show good detail in the light of the train immediately behind the meteor, termed either the evanescent train or wake. The chief feature of this light is the complete absence of all ionized atoms except Ca II, and the relatively greater strength of the multiplets Fe I (1), (2), (3), Mg I (1) and Ca I (1). In one case there is clear evidence that this trailing luminosity was produced by a small portion that broke off from the main mass, and luminous dust at a lower excitation than the meteor head may be a common feature in the wake of fast fireballs. The train spectra photographed in 1952 show the lines of Ca II, in contrast to the train of the 1949 meteor[9] in which they were absent.

Peter M. Millman

Dominion Observatory,
Ottawa, Ont. Aug. 22.

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Geomagnetic Activity and the Sunspot Cycle

It is well known that the daily international magnetic character figure C_i constitutes a valuable index for classifying days according to their magnetic activity averaged over a large part of the earth. As a measure of the intensity of geomagnetic disturbance, C_i is in fact comparable to the Zurich relative sunspot number S, which is a recognized measure of solar activity. Daily C_i values are available in an unbroken sequence from 1884 onwards.

In the course of a recent study of solar prominences recorded at Kodaikanal during the period 1905–50, the daily C_i figures for this period were analysed year by year into four groups: 0–0·4; 0·5–0·9; 1·0–1·4; and 1·5–2·0. These four groups may be conveniently designated as magnetically calm (D_1), slightly disturbed (D_2), moderately disturbed (D_3) and highly

disturbed (D_4) days. To study the behaviour of geomagnetic activity during the last four sunspot maximum epochs, with their peaks in 1947, 1937, 1928 and 1917, a period of five years centred around each of these peaks was taken and the total number of days (1,826) in this interval was classified into the four groups D_1 to D_4. As a measure of sunspot activity (S) for the corresponding periods, the Zurich relative sunspot numbers for the individual years were summed. As a measure of prominence activity (P) for the periods the mean daily profile areas of limb prominences were similarly summed. The results are as follow :

Epoch	D_1	D_2	D_3	D_4	S	P
1945–47–49	755	637	321	113	549·6	21,316
1935–37–39	671	594	574	187	429·3	31,389
1926–28–30	716	582	371	157	311·4	30,178
1915–17–19	672	592	428	134	350·9	22,079

It is at once seen that, judged both by the number of highly disturbed and least disturbed days, the latest sunspot maximum epoch has been geomagnetically the least active. However, it is well known that spot activity during this cycle has been one of the highest on record. We also see that the previous cycle with its maximum in 1937 was geomagnetically the most active among the last four solar cycles. Comparison of the figures under D_4 and S shows that the frequency of magnetically highly disturbed days does not run parallel to sunspot activity. However, comparison of the figures under D_4 and P indicates a parallelism. High prominence activity is also associated with high geomagnetic activity. (In this connexion it should be mentioned that the P figure for 1915–19 is not quite comparable with the figures for the remaining epochs. The prominence data prior to 1922 are based on observations made at Kodaikanal only, whereas after that year the Mt. Wilson and Meudon Observatories have been co-operating with Kodaikanal by supplying copies of their photographs for the days on which observations were not possible at this station.)

The fact that prominence activity during the latest solar cycle has been less compared with the two previous cycles has been pointed out in a previous communication[1]. It is worth recalling that Behr and Siedentopf[2] and Kleczek[3] have found from their analyses of solar flare data that flare activity has also been less during the latest solar cycle as compared with the previous cycle.

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Kodaikanal Observatory,
India. Sept. 11.

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Radio Noise-bursts from Solar *M*-Regions

In 1932, Bartels put forward the hypothesis that moderate geomagnetic storms with gradual commencements were associated with certain active regions on the sun which he called M-regions. Solar and geomagnetic studies in later years have confirmed the existence of these magnetically effective areas ; but their exact nature still remains obscure. Some authors consider them to be regions from which sunspots have just disappeared, leaving behind a certain amount of activity ; others regard them as long-lived dark filaments emitting slow corpuscles and closely connected with bright coronal patches. Our knowledge about the origin of the more intense geomagnetic storms, on the other hand, is more certain. These are characterized by sudden commencements and show very close correlation with solar flares, which occur in the neighbourhood of spot-groups. Observational results of recent years have provided satisfactory evidence of the emission of both corpuscular and electromagnetic wave radiations from intense solar flares ; the geomagnetic storm associated with a flare is due to the corpuscles and commences about one to two days after the optical observation of the flare, and the ultra-violet component of the wave radiation produces, in favourable circumstances, a 'crochet' in the magnetic traces synchronously with the flare, while the long-wave component in the radio-frequency region appears as a noise-burst almost synchronously with the flare. But, to our knowledge, no observational evidence has so far been published indicating that M-regions also can produce crochet-like disturbances in geomagnetic records and simultaneously emit radio waves similar to the noise-bursts from flares. The evidence provided by our recent observations in this regard is therefore of interest.

From the recurrence tendency of certain moderate magnetic storms investigated recently in this Observatory by B. N. Bhargava and A. M. Naqvi (this work is concerned with the study of the equinoctial increase in geomagnetic activity and will be published elsewhere), we were aware that an M-region would be traversing the disk between about August 18 and 31, 1953. Indeed, on the basis of this knowledge, this Observatory had issued a forecast of ionospheric and geomagnetic disturbances which proved to be successful. The predicted magnetic disturbances actually began on August 23 and ended by September 1. While the magnetic disturbances were in progress, the traces of all our H-magnetographs (Watson, La Cour and Askania) showed on August 24 and 25 two short-duration disturbances synchronously with two noise-bursts recorded by our 100-Mc./s. radio telescope. The same phenomenon occurred again on August 29. We reproduce in Fig. 1 the magnetic and solar noise records for the relevant periods. It will be noticed that the crochet-like disturbance in each case shows fluctuations identical in character to the variations of intensity in the noise-burst. Evidently this transient magnetic disturbance was caused by ultra-violet radiation emitted by the M-region, but it was not exactly like the usual crochet ; nor was there any associated radio fade-out so far as could be judged from our ionospheric records, which are taken at 15-min. intervals. The close correspondence between the characters of the short-duration magnetic disturbance and the noise-burst seems to suggest a phase relationship between the intensity of ultra-violet emission and the intensity of radio-frequency radiation. It is tempting to infer from this that the ultra-violet radiation pressure was directly responsible for the variations in the acceleration of charged particles, giving rise to the radio-frequency emission.

It seems significant that throughout the period August 24–29 the spectroheliograms of this observatory showed that the visible disk was remarkably free from disturbances. There were no spots or calcium or hydrogen flocculi visible during this period, except for a very small flocculus visible on both K and H_α disk spectroheliograms very close to the east limb on August 29. On the hydrogen disk spectroheliograms there were only two or three very

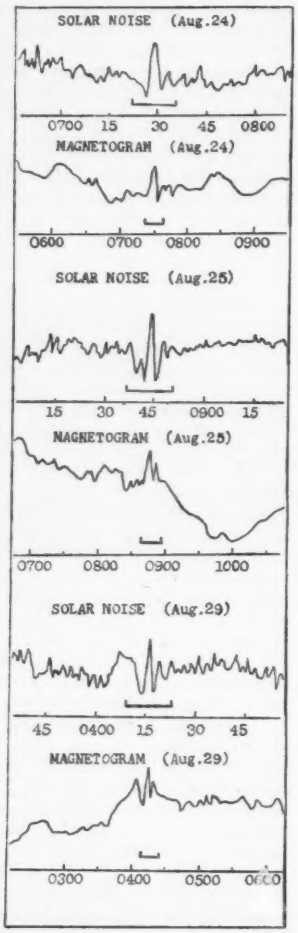

Fig. 1. Solar noise records and magnetograms (times in U.T.)

small and insignificant-looking absorption markings, which showed no activity as observed with the spectroheliosope during the period in question; nor could they be identified as recurrent filaments during the previous transits of the *M*-region. The emission of ultra-violet radiation from the *M*-region could not, therefore, be attributed to any associated calcium or hydrogen flocculus in the manner suggested by Wulf and Nicholson[1]; although the three instances here cited demonstrate that emission of ultra-violet radiation does take place, at least in spurts, from an *M*-region. Neither does it seem possible to identify this *M*-region with any long-lived filament emitting slow corpuscular radiation, as suggested by Kiepenheuer[2].

We have examined our past magnetic and solar noise records for several months during which this particular *M*-region had been effectively causing recurrent magnetic disturbances. Although we think that there are indications of similar magnetic and noise phenomena during the previous transits of this *M*-region, the three instances here reported are by far the clearest and most striking. But from the examination of our past records, we feel convinced that the passage of *M*-regions is characterized by a notable increase in the short-term variability of noise intensity on 3-metre wave-length as compared with the quiet sun. Further observations are much to be desired, especially during the present minimum phase of the solar cycle.

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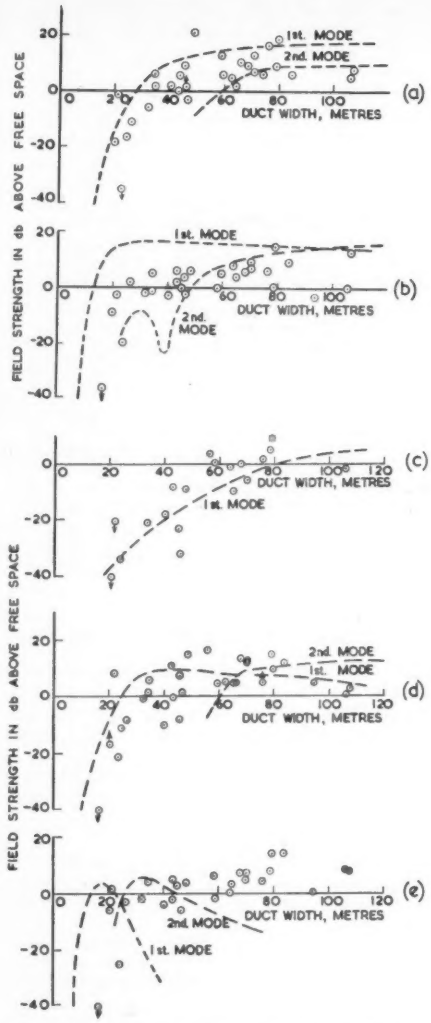
Ultra-short-wave Field-strength in a Ground-based Radio Duct

Although powerful methods have been developed for calculating the field-strength beyond the horizon of a transmitter for various profiles of atmospheric refractive index[1-3], the success achieved in their practical application has been somewhat limited[3,4]. The chief reason for this is that the refractive-index profile usually varies considerably along the transmission path, especially in coastal regions[5], and in this case the calculation of the full solution, if more than one propagation mode has to be taken into account, becomes prohibitively complex[6]. It is useful, therefore, to seek an empirical relationship between the field-strength and the characteristics of the refractive-index profile averaged by some means along the transmission path. Suitable experimental data have recently become available in a report published by the New Zealand Government[7], which contains a large number of field-strength observations made at various heights over the sea under widely differing super-refractive conditions. It can be shown[1] that the width of the radio duct is the most important single parameter in determining the field-strength beyond the horizon of a transmitter, and we therefore confine our attention to the duct width in the following discussion. Ground-based ducts only are considered.

The New Zealand field-strength observations were made at wave-lengths of 3, 9 and 60 cm., in ducts from about 15 to 100 m. in width, at ranges between about 20 and 200 km. from the fixed terminals at the coast. The transmission path was divided into 20-km. intervals, centred at 20 km., 40 km., etc., up to 200 km. from the fixed terminals, and the average duct width out to each of these ranges was determined from the smoothed refractive-index data as given in the report. The maximum value of the field-strength in the region of the duct was then determined from the records. At 3 and 9 cm., the height of the maximum usually lay between 10 and 30 m. from the sea surface, and at 60 cm. between 30 and 60 m. Where the field-strength/height curves showed no local maximum in the region of the duct (that is, when the lowest propagation mode was very leaky), the value at the top of the duct was taken.

The maximum field-strength values plotted against the average duct width are shown in the diagram for the 20-km. range-interval centred at 100 km. from the fixed terminals. As the duct width increases from zero, the field-strength generally increases from a low value up to a certain level, beyond which it remains almost constant or tends to increase only slowly with further increase in duct width. Such a relationship would be expected from theory[1], the change occurring at the duct width where the first mode goes from a leaky to a trapped state, referred to here as the 'critical' duct width. Owing to the



Maximum field-strength in duct at 100 km. as a function of duct width.
$\delta\delta$, Field-strength less than (greater than) indicated by < 10 db.; – – –, theoretical value of maximum field-strength in duct for one-half power law refractive index profile.
(*a*) Wave-length, 9 cm. } terminal height, 8 m.
(*b*) Wave-length, 3 cm. }
(*c*) Wave-length, 60 cm. }
(*d*) Wave-length, 9 cm. } terminal height, 26 m.
(*e*) Wave-length, 3 cm. }

amount of scatter, the critical value cannot be determined with precision from the plots; it appears to be about 27 m. at 3 cm. wave-length, 45 m. at 9 cm., and nearly 90 m. at 60 cm. wave-length. The scatter is generally much greater for duct widths less than critical than for wider ducts. For all plots the amount of scatter at each wave-length tends to increase with range. This is to be expected from the method of calculating the duct width[6].

An interesting feature brought out by the analysis is that the field-strengths at 9-cm. wave-length for duct widths greater than critical are, on the average, greater than the corresponding values at 3 cm. Between the range of 50 and 100 km., the average

Range Interval	Average horizontal attenuation (db./km.)		
	9-cm. wave-length	3-cm. wave-length	Theoretical value for a trapped mode
50–100 km.	0·09	0·16	0·06
150–200 km.	0·05	0·08	0·025

factor is 3·8 db., while between 150 and 200 km. it is 5·1 db. These figures imply also that the horizontal attenuation is greater at the 3-cm. wave-length than at the 9-cm. The attenuations for duct widths greater than critical are shown in the table.

The significantly greater attenuation at 3 cm. is probably due to the greater amount of scattering from the sea surface at the shorter wave-length. This conclusion is similar to that reached by Pekeris[4] in analysing the results of experiments made in the Caribbean Sea in 1945[8].

An empirical formula for determining the maximum field-strength in the duct as a function of duct width would be of little use for ranges beyond 100 km. from the transmitter, owing to the amount of scatter in the results. At less than 100 km. the scatter is only moderate at all three frequencies, at least for duct widths greater than critical; but it is doubtful if any empirical formula would be much better than one based on simple mode-theory for a horizontally stratified atmosphere with the duct width equal to the average value. This is shown by comparing the experimental points in the figure with the theoretical curves calculated from Booker and Walkinshaw's formula[1] for a one-half power law profile of modified refractive index. At 3-cm. wave-length the term in this formula depending on the fixed height of the ground terminal has an undue influence on the shape of the curves; much better agreement with the experimental values could be obtained by making reasonable assumptions about the contribution due to this term, and allowing for the extra horizontal attenuation at this wave-length.

It appears, therefore, that if the average width of a ground-based duct can be predicted from meteorological data to be greater than the critical value for some particular wave-length, a useful, though rough, estimate of the maximum field-strength in the duct can be made at centimetre and decimetre wavelengths, at least up to ranges of 100 km. from the transmitter.

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Application of a New Adsorption Method in the Study of Flow of Fluids

In a paper entitled "Adsorption under Fixed Hydrodynamic Conditions, I"[1], we have expressed the opinion that under our conditions adsorption can be used for the investigation of the flow of liquid fluids. The object to be examined is coated with a thin layer of silica gel by spraying it with a suspension of finely powdered silica gel in an acetone solution of cellulose nitrate. If an object thus prepared is placed in a stream of a dilute aqueous solution of methylene blue (0·00015 per cent) and allowed to stand for 5–20 min., on the white surfaces of the object there will appear uneven blue colorations or 'adsorption spectra'. We think that the differences in intensity of coloration, that is, the differences in the amounts of the adsorbed colour, are the consequence of different thicknesses of the boundary layers in the stream of fluid above the boundary surface. Since, in order to reach the surface of the adsorbent, the coloured substance should diffuse through one part of the boundary layer, therefore, the thinner the boundary layer the greater the amount of the coloured matter which will diffuse in the same period of time.

We have obtained results (unpublished) confirming this and showing that the intensity of coloration of the surface area of the adsorbent depends on the rate of flow of the fluid, and that the greater the rate of flow the greater the intensity of coloration at the surface of the adsorbent; at the same time, the intensity of coloration is greatest on smooth surfaces in places where the solution first reaches the surface, and it gradually decreases along the surface. This leads to the conclusion that the thickness of the boundary layer decreases with the rate of flow and increases with the distance which the fluid flows. This is in complete agreement with the theoretical suppositions. It means that above intensely coloured places on the object the boundary layer is relatively thin, due to high speeds, or to the direction of flow being at right angles to the boundary surface. Faintly coloured places, according to our view, indicate low rates of flow of the solution, slight whirls, places from which the boundary layer diverges, or places where there is no flow or currents of opposite directions are meeting, thus producing 'dead' zones.

Such 'adsorption spectra' have been produced on aluminium plates (137 mm. × 25 mm. × 1·1 mm.) to which were fastened the objects the effects of which on the rate of flow we wished to examine. The objects were coated with silica gel as described earlier, and placed in a long straight tube (diameter 26·0 mm.) through which, for a period of 5 min., a solution of methylene blue was allowed to flow at a given rate.

In one experiment, with a vertical cylinder (diameter 12 mm., height 14 mm.) and at a velocity of 0·44 m./sec., various semicircular, rather faintly coloured concentric surfaces appear, pointing to the 'dead' zones caused by the meeting of whirls in front of the object. On the front surface of the cylinder, as well as at its sides, faintly coloured places are seen which are the consequences of the diversion of the boundary layer from the cylinder. The faintly coloured places behind the cylinder are the consequences of relatively slow movements of slight whirls, whereas on the sides of the cylinder the intensely coloured areas due to streaming at high rate of flow are shown. When a diffusor is introduced into a stream of velocity 0·35 m./sec., it is characterized by a narrow band or dead zone at the entrance to the diffusor, due to the collision of opposed fluid streams with the narrow surfaces of the diffusor. Another characteristic is the non-homogeneity of the flow of the fluid shown by the adsorption spectrum in front of the entrance to the diffusor and its homogeneity at the exit.

We believe that this adsorption method of studying flow has several new and useful characteristics: it gives permanent records—'adsorption spectra'—even of the most complex flows along the actual surface without the aid of photographic or other measuring instruments; it is simple; it can be used for large surfaces; and it can also record 'micro flows' which are difficult to observe by other methods. We believe that the method, supplemented by colorimetric measurement of intensity, indicates a means of passing from qualitative to quantitative demonstrations of flow.

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A Relativistic Treatment of Rigid Motion

In the following we shall set up Lorentz-invariant equations for the rigid motion of pairs of points and then inquire into the way special relativity modifies the classical kinematical properties of rigid bodies.

Starting from the principles used by M. Born[1] in arriving at the conditions of rigid motions of continua, we shall consider the motion of the point $P_2[\mathbf{r}_2 = \mathbf{r}_2(t)]$ rigid in relation to the point $P_1[\mathbf{r}_1 = \mathbf{r}_1(t)]$, whenever the s_{12} world distance drawn perpendicularly to the world line of P_1 from any point $\mathbf{r}_2(t_2)$ of t_2 time of the world line of P_2 appears to be constant:

$$\frac{d\mathbf{r}_1(t_1)}{d\tau_1}[\mathbf{r}_1(t_1) - \mathbf{r}_2(t_2)] - c^2\frac{dt_1}{d\tau_1}[t_1 - t_2] = 0, \quad (1)$$

$$[\mathbf{r}_1(t_1) - \mathbf{r}_2(t_2)]^2 - c^2[t_1 - t_2]^2 = s_{12}^2. \quad (2)$$

In this system of Lorentz-invariant equations, τ_1 is the proper-time of the point P_1 at the value $t_1 = t_1(t_2)$ of the system-time, in which the condition (1) of orthogonality has just been satisfied.

The function $t_1 = t_1(t_2)$, that is, equation (1) determining the time t_1 to be considered later 'conjugated' to t_2, may be written, provided the condition $\dot{\mathbf{r}}_1^2 < c^2$ is satisfied, also in the following form:

$$\frac{d\mathbf{r}_1(t_1)}{dt_1}[\mathbf{r}_1(t_1) - \mathbf{r}_2(t_2)] - c^2[t_1 - t_2] = 0. \quad (3)$$

Owing to the function $\mathbf{r}_j = \mathbf{r}_j(t)$ $[j = 1,2]$ being of single value, the derivative $dt_2/dt_1 > 0$. By differentiating equation (2) with respect to t_1 we may set up also symmetrical conditions instead of (1, 2), which appear to be asymmetrical in j. We may then write, on considering (3):

$$\frac{d\mathbf{r}_2(t_2)}{dt_2}\,[\mathbf{r}_2(t_2) - \mathbf{r}_1(t_1)\,] - c^2[t_2 - t_1] = 0. \qquad (4)$$

Unlike equations (1, 2), equations (3, 4) are symmetrical with respect to j. For this reason the rigidity of P_1 as regards P_2, as well as the correlation of their system-times, are reciprocal. The postulate of rigidity as put forward in the foregoing may be expressed also by equations (2, 3).

If $\dot{r}_j = 0$ holds good at one, at least, of the points, then $t_1 = t_2$ and, consequently, s_{12} appearing in equation (2) must necessarily always mean the (invariant, intrinsic) spatial distance of the pair of points.

From equations (2) and (3), the following statements can be made:

(1) A rigid pair of points moving in its own direction with constant velocity shows Lorentz–Fitzgerald contraction.

(2) On a line at rest two points with accelerations identical and constant in time do not move rigidly. In consequence, the theory of relativity does not, in any of its aspects, allow the construction of a rigid system of co-ordinates of constant acceleration.

(3) In an inertial system, a rigid plate rotating with constant angular velocity is definable, but on its plane the intrinsic metric is non-Euclidean, and this meets correctly the calculations made by C. W. Berenda[2] and N. Rosen[3].

(4) A rigid pair of points has five degrees of freedom, provided that $s_{12} \neq 0$.

(5) If P_1P_2, P_2P_3 and P_3P_1 are rigid pairs of points (a 'rigid triangle') and $(s_{12} \pm s_{23})^2 \neq s_{13}^2$, this rigid triangle then has six degrees of freedom.

(6) If, however, $(s_{12} \pm s_{23})^2 = s_{13}^2$, that is, the three points lie on a rigidly moving straight line (the triangle having degenerated to a straight line), the orbit of P_3 may be calculated from the orbits of P_1 and P_2:

$$\begin{aligned} t_3 &= t_1 \pm (t_1 - t_2)\, s_{13}/s_{12}, \\ \mathbf{r}_3(t_3) &= \mathbf{r}_1(t_1) \pm [\mathbf{r}_1(t_1) - \mathbf{r}_2(t_2)\,]\, s_{13}/s_{12}. \end{aligned} \qquad (5)$$

(7) A rigid triangle may be fixed permanently in an inertial system.

(8) The orbit of a point rigid in relation to all the three points of a rigid triangle not degenerating to a straight line is determined by the orbits of the three points (the case of a 'rigid tetrahedron').

(9) If there exists a value of the system-time at which all three points of the base of a tetrahedron are at rest in an inertial system, the vertex of this tetrahedron will, at the same value of the system-time, be at rest as well.

(10) The vertices not common of two rigid tetrahedrons ('bitetrahedron') possessing a common base can, in general, not be rigid relative to each other.

It follows from (7), (8) and (9) that the vertices of rigid bitetrahedrons may be permanently stopped in an inertial system and, by this, we may map all the five vertices of the bitetrahedron on a fixed congruent bitetrahedron in Euclidean space. If all the ten combinations of the five points of a rigidly moving bitetrahedron were rigid, the same relation determining the metric would then exist, even during motion, between the ten invariant space-distances s_{jk} constant in time, as with that of a fixed congruent bitetrahedron placed in Euclidean space. We have, however, found in the foregoing that there may exist also a non-Euclidean metric with rigidly moving bodies. Consequently, not all the ten pairs of points can necessarily be rigid.

We may, therefore, state that a system of more than four points, moving rigidly, in all possible combinations is, in general, undefinable[4]. The definition of such a system would demand the abandonment of three of six degrees of freedom, a view already put forward by G. Herglotz[5].

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A Simple Formulation of the Unquantized Laws of Electrodynamics

As a preliminary to quantization, it is desirable to have the laws of classical, relativistic electrodynamics in their simplest possible form. The following formulation of the laws governing the flow of a continuous distribution of electricity is offered.

If there is no interpenetration of streams, the fluid is fully described by its time-like, divergence-free current-density 4-vector **J**, the 'flow vector' for short. The 4-velocity **U** is along **J** and is of unit interval: $\mathbf{J} = N\mathbf{U}$, where N is the charge density measured in the local rest-frame. It is usual to absorb the sign of the charge in N and to let **U** be a 'future' vector always; but our formulation is simplified by keeping N positive and letting **U** take up the sign of the charge so that it becomes a 'past' vector where the fluid is negative. The three ratios of the space-components to the time-component still give the correctly orientated non-relativistic 3-vector of velocity.

Accepting direct action between streams one would, intuitively, expect manifestations of **J** only at zero-interval points in the future. Hence an intuitively effective flow-vector **A** results from **J** by weighting with the delta-function that singles out the light-cone and integrating over the entire past:

$$\mathbf{A}(\mathbf{r}) = 2\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\int_{-\infty}^{t} \mathbf{J}(\mathbf{r}')\,\delta\,((\mathbf{r}-\mathbf{r}')^2)\,dx'\,dy'\,dz'\,dt'.$$

With the factor 2, the effective flow vector **A** becomes exactly the 4-vector of the retarded potentials.

The effect caused by **A** is that of directing **J**, that is, determining **U**; for with mc^2/e as unit of potential (the mass/charge ratio of the fluid is assumed constant in magnitude) and the agreed sign convention, we obtain this convincingly concise statement of the Maxwell–Lorentz laws: "The sum of the local normalized flow-vector, **U**, and the locally effective flow-vector, **A**, maintains constant circulation". This follows from the equations of motion[1], but can be shown also to be a sufficient condition for the equations of motion to hold. The field concept is eliminated and any vacuum gaps are looked after automatically in the definition of **A**. Co-existing positive and negative streams with m/e ratios of the same magnitude

are covered by the same law, without change of sign. With interpenetration, **J** is multi-valued, but **A**, the total over all streams, is not. The law holds separately for each stream.

Superconductivity[2] would make one suspect that where quantum effects are important, $\mathbf{U} + \mathbf{A}$ is altogether irrotational and that large-scale vorticity arises only because multiply-connected charge configurations occur: in these an irrotational $\mathbf{U} + \mathbf{A}$ can have circulation (fluxoid[2]) of integral strength in units hc/e around non-contractible paths. One could go further, lay down the quantization of vortices as a fundamental law and thus revive the Bohr–Sommerfeld theory in an invariant manner. Some recent calculations have strengthened a conjecture that the free electron represents the continuous charge distribution around one or two elementary vortices.

A full account of this work has been submitted to the Cambridge Philosophical Society for publication.

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A Comparison of Lead Isotope Analysis Techniques

This communication reports the results of measurements of the relative abundances of the lead isotopes in a sample of lead analysed with the mass spectrometer at the Department of Physics, University of Toronto, Canada, and an instrument at the Atomic Energy Establishment, Harwell, England.

The purpose of this investigation was to compare isotopic lead analyses made using different techniques and different mass spectrometers. The results are of considerable importance in connexion with the methods of geological age determination based on the isotopic constitution of both radiogenic and ore leads.

The Toronto mass spectrometer was a 180°-instrument utilizing a Nier-type source. The sample in the form of lead tetramethyl was introduced through a capillary leak, and ions were produced by bombardment with a beam of 75-volt electrons. Full details of this technique have been published elsewhere[1].

The Harwell instrument was a 60° Nier-type spectrometer; the source arrangement consisted of a normal Nier-type gas source with a small furnace incorporated for distilling the material in the form of lead chloride or lead iodide into the ionization chamber. Magnetic scanning was utilized with both spectrometers.

The accompanying table gives the results of the analyses; several separate runs using fresh quantities of sample were made with each instrument.

The agreement of the Toronto and Harwell results suggests that isotopic analyses made using lead tetramethyl agree well with those involving the use of solid lead compounds as sources of ions. The effects of mass discrimination appear to be negligible, although a slight discrepancy in the abundances of lead-204 remains to be resolved. The results also serve to indicate the general reproducibility of lead isotope analyses.

We wish to thank Dr. L. R. Stieff, of the United States Geological Survey, for supplying the original samples of pure lead. Portions of this sample have also been supplied to other laboratories in the United States engaged in lead isotope work, and the results of their analyses will be published in the future so that all lead isotope studies will be strictly comparable.

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Isotopic Analyses of Lead Sample

Laboratory	Mass spectrum observed	Relative isotopic abundances (per cent) ^{206}Pb	^{207}Pb	^{208}Pb
Toronto	$Pb(CH_3)_3^+$	1·43 (8)	23·72	22·60	52·21
	"	1·45 (0)	23·66	22·60	52·31
	"	1·43 (9)	23·74	22·39	52·45
	"	1·43 (2)	23·63	22·57	52·37
	Pb^+ "	1·43 (9)	23·68	22·55	52·35
	Average	1·44 (0) ± 0·009	23·69 ± 0·02	22·54 ± 0·04	52·33 ± 0·04
Harwell (average of 3 runs)	$PbCl^+$	1·44 (8) ± 0·012	23·62 ± 0·04	22·56 ± 0·04	52·37 ± 0·15
	Pb^+	1·46 (2) ± 0·014	23·65 ± 0·06	22·63 ± 0·06	52·27 ± 0·11
(average of 2 runs)	PbI^+	1·45 (9) ± 0·008	23·70 ± 0·04	22·63 ± 0·03	52·20 ± 0·09
	Pb^+	1·45 (0) ± 0·007	23·58 ± 0·05	22·60 ± 0·06	52·37 ± 0·05
	Average	1·45 (5) ± 0·007	23·64 ± 0·05	22·61 ± 0·03	52·30 ± 0·07

All deviations quoted above are standard deviations

Colour Bands in Fluorspar

It has been shown in previous publications[1] that at least some of the maxima in the absorption spectra of natural coloured fluorites coincide with those obtained by artificial irradiation, thus completing the proof that the natural colour is due chiefly to radioactivity. Different fluorites show, however, very different colours and absorption spectra. This might be due in part to the fact that the conditions of formation of these minerals may vary greatly. It seemed, therefore, to be of interest to study the bands of different colour which are frequently seen in the same sample of fluorite, in which case the conditions of formation cannot have varied so much.

With a translucent piece of fluorite from Pe-shan, Che-Chian Province, China, a gift from Prof. Iimori, Tokyo, green with purple stripes, H. Adler, in the II Physics Institute, University of Vienna, was able to measure the absorption spectra of the green and

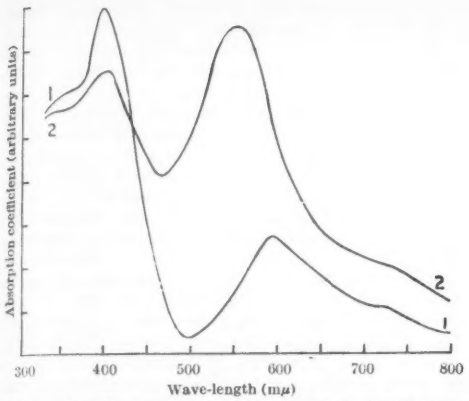

Fig. 1. Absorption spectra of the green (1) and violet (2) bands in fluorite from Pe-shan (China). Measurements from 10 to 50 mμ

the purple regions (see Fig. 1). It is seen that the purple (curve 2) differs from the green (curve 1) by the displacement of the maximum at 595 mμ to 555 mμ. There are also maxima at 400 mμ and, as an analysis of the curves shows, at 335 mμ and between 710 and 750 mμ. The maxima at 335 and 400 mμ were also obtained by A. Smakula[2] with artificial crystals of calcium fluoride coloured by X-rays.

As has been shown[3], the green in fluorites can be changed to grey or violet by pressure. An inverse effect has now been found in a fluorite from the Ramshaw Mine, Weardale, coloured partly green, partly lilac: careful heating turns the lilac to green, while stronger heating decolorizes the sample as usual.

In this fluorite, as in many others, and also in the Chinese one mentioned above, the green parts show stronger fluorescence under ultra-violet excitation than the violet parts. It could be proved in the case of the Chinese fluorite that this is not due to the blue light emitted (bivalent europium)[4] being more absorbed in the violet parts; on the contrary, these are more transparent to it, and they also transmit more ultra-violet light than the green parts. It seems that the green parts contain more bivalent rare earth ions than the violet ones.

At liquid-air temperature the fluorescence of the Ramshaw Mine fluorite is often blue (Eu^{++}) in the green parts and green (bivalent ytterbium) in the lilac parts; but in some samples both regions show the green fluorescence of Yb^{++}, the green parts again stronger than the lilac ones. That these samples show the Yb^{++}-fluorescence is slightly anomalous as in general it is only predominant in fluorites near acid magma[5], which is not present in the Weardale deposits. Undoubtedly, there is a variation in the relative concentration of Eu^{++} and Yb^{++} in the differently coloured regions. The thermoluminescence is also stronger in the green than in the lilac parts. These observations are in agreement with those of R. D. Allen[6], who states that green fluorites are generally more luminescent than others and relatively rich in rare earths.

In order to see if there is a connexion between colour and degree of radioactivity, Dr. Hanne Lauda, in this Institute, is testing polished slabs of green and violet striped fluorite with nuclear plates. A preliminary scanning of the plates exposed so far seems to show that there is no *strict* correlation between the colour and the very irregularly distributed radioactivity, but that in general the radioactivity is more concentrated in the darker, violet regions. What sort of colour centres are formed will depend on their stability[7], on the impurities, radioactive and inactive, and other imperfections present in the layers of growth.

I wish to thank Dr. Hanne Lauda and Mr. H. Adler for their help and the Directors of the Blanchland Fluor Mines, Ltd.—and especially Mr. E. Godfrey, mine manager—for their gift of fluorspar specimens and an interesting visit to the Ramshaw Mine, Weardale.

A more detailed report will be presented in due time to the Austrian Academy of Sciences.

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July 13.

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[2] Smakula, A., *Phys. Rev.*, **77**, 408 (1950); "Verfärbung und Lumineszenz", 168. It can be pointed out here that these artificial crystals still contain appreciable traces of rare earths, as follows from the coincidence of the maxima in the thermoluminescence spectra observed by Hill, J. J., and Aron, J. (*J. Chem. Phys.*, **21**, 223; 1953), with the well-known rare earth emission lines.

[3] "Verfärbung und Lumineszenz", 173.

[4] "Verfärbung und Lumineszenz", 188.

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Polarographic Effect of Carbon Dioxide in Solutions of Ethyl Alcohol

A POLAROGRAPHIC depolarization effect due to carbon dioxide in aqueous solutions occurring at $-2{\cdot}2$ V. (from the normal calomel electrode) has been described by Van Rysselberghe[1] and v. Stackelberg[2]. This effect is, however, indistinct. When using absolute (99·8 per cent) ethyl alcohol with $0{\cdot}3\ M$ tetramethyl ammonium chloride in electrolysis with the dropping mercury cathode, a well-defined wave with a maximum at -2 V. (Fig. 1) is formed on the current-voltage curve. The behaviour shows it to be due to the evolution of hydrogen from carbonic acid, the carbon dioxide molecule being regarded as not reducible. Here nitrogen containing 4 vol. per cent of carbon dioxide was bubbled through the solution for 3–4 min. at room temperature. The equilibrium concentration of carbon dioxide dissolved under its pressure in the gaseous phase is attained very quickly (in about 2 min.). The ensuing limiting current is strictly proportional to the partial pressure of carbon dioxide.

If the gas contains besides carbon dioxide also oxygen, the current-voltage curve reveals the two oxygen waves as well; however, the carbon dioxide wave is diminished as the amount of oxygen is increased. This diminution is evidently caused by hydroxyl ions, produced in the electro-reduction of oxygen, which join the acid to form the non-reducible carbonate ions, CO_3''.

The diminution of the carbon dioxide wave is to a large extent removed when hydrochloric acid is added to make the $0{\cdot}3\ M$ tetramethyl ammonium chloride solution $0{\cdot}015\ M$ in hydrochloric acid. The hydroxyl ions formed in the reduction of atmospheric oxygen are then entirely neutralized, so that no

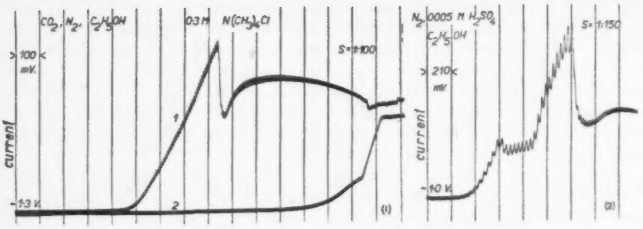

Fig. 1. (1) Current-voltage curve obtained in an atmosphere of nitrogen, the electrolyte being 0·3 *M* tetramethyl ammonium chloride in 99·8 per cent ethyl alcohol. (2) Curve after bubbling with nitrogen containing 4 vol. per cent carbon dioxide. Curves start at − 1·3 V. Abscissæ 100 mV., sensitivity 1 : 200

Fig. 2. Current-voltage curve obtained in an atmosphere of nitrogen in ethyl alcohol containing 0·3 *M* tetramethyl ammonium chloride with 0·005 *M* sulphuric acid. Abscissæ 210 mV., sensitivity 1 : 150

carbonate ions may be formed. These conditions are suitable for a continuous automatic record of carbon dioxide in gases.

The evolution of hydrogen due to hydrochloric acid yields in absolute alcohol in the absence of oxygen a wave at − 1·5 V., evidently due to the deposition of free hydrions, while the wave of carbon dioxide remains at − 2 V. Practically the same polarogram with two waves is obtained when, instead of hydrochloric acid and carbon dioxide, the ethyl alcohol contains sulphuric acid in equivalent concentration (Fig. 2). Here evidently both waves are due to the evolution of hydrogen, which is deposited in the first wave, at − 1·5 V., from free hydrions, and in the second wave, at − 2 V., from the complex HSO_4^-.

Hence it is concluded that the polarographic wave shown in the presence of carbon dioxide is also due to the evolution of hydrogen from complex particles of solvated carbon dioxide, like HCO_3^-, H_2CO_3, $C_2H_5HCO_3$.

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A New Method of Separation of Organic Compounds

During attempts to purify a yellow crystalline compound obtained from acetone extract of resin, *Canarium strictum* Roxb., which could not be purified either by recrystallization with various solvents and mixtures of solvents or by chromatography over alumina and calcium sulphate, a new method of separation of organic compounds by fractional crystallization on filter paper has been developed.

Schonbein[1] and Goppelsroeder[2] were the first to utilize the separation effected by capillarity, in analytical work on organic compounds which they called "capillary analysis". After our unsuccessful attempts to purify the yellow crystalline compound mentioned above, we considered that the separation may be better effected on filter paper where capillary action would be more pronounced and fractional crystallization might occur with the added aid of capillary analysis. One would have expected that such a phenomenon would have been noticed during the early work of Schonbein and Goppelsroeder (*loc. cit.*).

To test the above view, a filter-paper strip was suspended in a 1 per cent solution of the yellow crystalline compound mentioned earlier, and exposed to the atmosphere. After half an hour, it was noticed that part of the substance had travelled up the filter paper. The resinous component remained in the pores of the filter paper and had travelled about half an inch clear of the crystalline compound. The melting point of the crystalline compound rose from 155° C. to 165° C., which on further irrigation on a fresh strip rose to 179–180° C. and remained constant. A number of experiments were conducted both with this mixture and mixtures of known compounds to evolve a general procedure for carrying out the separation. The method consists of two distinct steps.

(1) The deposition of the mixture on filter paper.

(2) Irrigating the filter paper with a pure solvent or a mixture of solvents to obtain separate zones of the components constituting the mixture.

The first step is accomplished by taking the mixture in a volatile solvent in an open dish and suspending vertically a filter paper strip (2 in. × 8 in.) (Whatman No. 3) so that its lower end dips in the solution, which is then allowed to evaporate until about 0·5 gm. of the mixture is deposited at the lower end. The dish containing the solution is now replaced by pure solvent or mixture of solvents and the system is enclosed in a bell jar, having a small opening

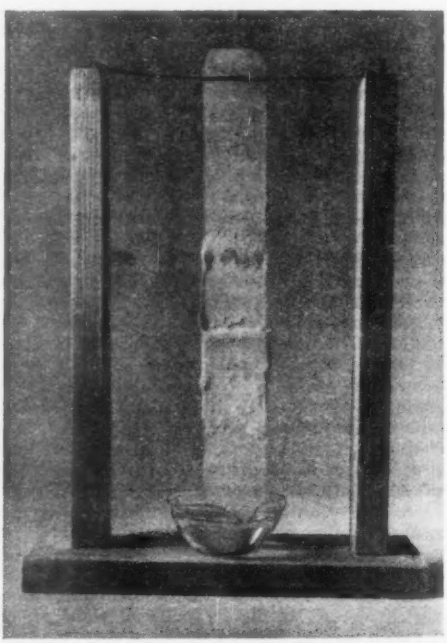

Fig. 1

at the base for steady evaporation. The rate of evaporation can be controlled by adjusting this opening. During the course of the next few hours, when no attention is necessary, part of the mixture travels farther up, forming a distinct zone (see Fig. 1). It is important that this process should be stopped at this stage, otherwise the lower zone also will rise and the separation obtained earlier is lost. The filter paper is cut in between the two zones and each run separately until pure fractions are obtained.

Using the above method, some known mixtures, (1) phenanthrene and anthracene, (2) naphthalene and bi-phenyl, (3) α-naphthol and β-naphthol, (4) hydroquinone and resorcinol, were easily separated. Hydroquinone and resorcinol, however, crystallized so well within the pores of the filter paper that one could not scrape them off without tearing the filter paper. Using wider strips, it is easy to separate larger quantities of substances in a short time.

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Phenylation, Benzoyloxylation and Halogenation of Aromatic Compounds by Silver Benzoate – Halogen Complexes

Although the reaction between halogens and the silver salts of carboxylic acids constitutes a fairly well-known method for the preparation of organic halides, its mechanism is far from clear. Several types of intermediate have been isolated or postulated by different workers[1,2]. Simonini[3] obtained complexes which he formulated as $(RCO_2)_2AgX$ (where X = halogen), for example, the so-called 'silver iodide dibenzoate'. Birckenbach and Meisenheimer[4] examined the decomposition of certain of these complexes in the presence of benzene, using a reaction between one equivalent of the silver salt and two equivalents of iodine. The formation of iodobenzene and the phenyl ester of the acid was reported. From a reaction between silver *p*-chlorobenzoate and iodine in boiling chlorobenzene, *p*-chlorophenyl *p*-chlorobenzoate was isolated. In this latter case, it is not clear from the experimental evidence whether the ester resulted from a reaction with the solvent, or whether both its *p*-chlorophenyl groups originated in the silver salt. It is known that esters, RCO_2R, can result from analogous reactions between silver salts, RCO_2Ag, and iodine[5]. A preliminary investigation of this subject has exposed several interesting new features, which are now briefly described.

Silver benzoate has been suspended in a number of aromatic compounds and treated with one equivalent of bromine or iodine at 20°. The resulting insoluble complex has been caused to decompose by heating at 80° (Br) or 130° (I). Silver iodide dibenzoate decomposes in chlorobenzene at 130° with the evolution of carbon dioxide and the formation of a mixture of isomeric chlorodiphenyls (22 per cent), chlorophenyl benzoates (5 per cent) and benzoic acid (35 per cent); the iodine appears almost quantitatively as silver iodide. Reduction of the chlorodiphenyls with Raney nickel gave diphenyl, and bromination gave a little 4-bromo-4′-chlorodiphenyl, melting point and mixed melting point 154–155·5°. The relative proportions of phenylation and benzoyloxylation in this experiment are similar to those which are found in the decomposition of benzoyl peroxide in aromatic solvents[6], and suggest a common basic mechanism, namely, the formation and subsequent decarboxylation of free benzoyloxyl radicals, $C_6H_5CO_2\cdot$.

In contrast, the decomposition of silver bromide dibenzoate in chlorobenzene leads to benzoyloxylation only, and not to any appreciable degree of phenylation. Of the mixture of chlorophenyl benzoates which was obtained (23 per cent), 30 per cent of the *para* isomer was readily isolated by crystallization: the true proportion was certainly higher than this. Only 70 per cent of the bromine appears as silver bromide. In nitrobenzene, silver bromide dibenzoate decomposes to give a mixture of nitrodiphenyls and *m*-nitrophenyl benzoate in approximately equal proportions. Little, if any, of the *para* ester is produced, for a blank experiment showed that the working-up process would tend to concentrate this isomer. The orientation in these benzoyloxylation experiments is regarded as a significant indication of their electrophilic character and of the intermediacy of benzoyloxyl cations—a hitherto unknown species. Unfortunately, the orientation in the homolytic benzoyloxylation of benzene derivatives is not yet known, and direct comparison with the present results is not possible. In homolytic phenylation and hydroxylation, *meta* positions are known to be relatively unreactive, and the effect of substituents in the aromatic ring is small. A homolytic mechanism for benzoyloxylation by silver bromide dibenzoate is therefore regarded as improbable. It may be noted in passing that this reaction represents a method for the direct oxidation of the aromatic nucleus.

Another type of reaction is illustrated by the decomposition of silver bromide dibenzoate (prepared in *n*-heptane) in anisole. This gives *p*-bromoanisole as the principal high-boiling product; but slight benzoyloxylation of the anisole also occurs. Silver iodide dibenzoate and silver iodide diacetate oxidize *iso*propylbenzene to acetophenone at 100°; the yields are low.

It is already clear that a common mechanism cannot be advanced for all reactions which involve halogens and the silver salts of carboxylic acids; but it is felt that detailed considerations should await the results of further experiments. An account of these will be given elsewhere in due course.

I would like to acknowledge the interest shown in this work by Prof. D. H. Hey and Dr. G. H. Williams. The work is being carried out during the tenure of an I.C.I. Research Fellowship at the University of London.

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Thermal Anomaly in the Elastic Constants of Chromium

Several investigators[1,2] have shown that at a temperature near 37° C. anomalies exist in some of the physical properties of pure chromium. In an earlier communication[3], we reported measurements which had been made here of the variation with temperature of the Young's modulus and modulus of rigidity of an electroformed tube of chromium which had been annealed for fifteen hours at 544° C., showing that a sharp minimum occurred near 37° C. in the velocity of propagation of longitudinal waves, corresponding to a fall in elastic modulus of about 2 per cent when measured on the fundamental vibration, but only to about 1 per cent when measured on the 8th harmonic. The modulus of rigidity–temperature curve showed only a small stationary region of modulus over a range of about 6° C. above the temperature of minimum longitudinal modulus, similar results being obtained on all measured harmonics.

We have now made considerable progress in investigating the transition in Young's modulus with temperature in various types of chromium, and can correct our former interpretation of the apparent frequency dependence of the anomaly, which is now seen to be due to invariance of the modulus of rigidity through the transition temperature and the consequent change in Poisson's ratio of the material.

In a paper by Fine, Greiner and Ellis[1] the authors suggest that the anomaly in Young's modulus may be related to the anomaly which has been observed in the volume expansivity of the material[1,2]. This anomaly occurs at a temperature which decreases with compressive stress, and so we may expect that the application of such a stress will cause the material to change towards the high-temperature modification, thereby producing an anomalous bulk strain in addition to the normal elastic strains. This extra strain will add to the elastic strain along the stress axis, but will tend to neutralize the strains normal to this axis, so that Young's modulus and Poisson's ratio will be simultaneously reduced. The reduction in Poisson's ratio will also reduce the dispersion which occurs on longitudinal waves[4–6], since it implies a reduction in the lateral component of vibration, and the difference between the velocities measured at low and high frequencies will therefore decrease as the temperature of the anomaly is approached. This means that the velocity as measured on higher harmonics will increase relative to that measured on the fundamental frequency, thus reducing the anomalous change in velocity on the higher harmonics. It should be added that direct evidence for the reduction in Poisson's ratio has been obtained from static extensometer measurements of lateral strain under a uniaxial stress, and it has been found that in certain impure samples of chromium the value of Poisson's ratio may actually become negative.

We have studied the effect of impurities on the transition, including iron, silicon, nickel and copper, and have shown that in general the transition will occur at a lower temperature in an impure material than in a pure sample. So far no impurity has been found which raises the transition temperature. The reduction in transition temperature and the magnitude of the change in modulus vary greatly with the type of impurity, and in the case of iron it has been found that the reduction in temperature is roughly proportional to the amount of impurity present. In other cases there is also a large increase in the extent of the change in modulus, which may sometimes be as much as 1·5 : 1. These large anomalies have been observed mainly in specimens containing silicon.

It is intended to publish a full account of this work when completed. In conclusion, I should like to acknowledge several helpful discussions with Dr. E. A. Calnan, and the large part played by Mr. J. H. Rendall, of the Metallurgy Division of the Laboratory, and Dr. A. H. Sully, of the Fulmer Research Institute, in the work of preparing specialized specimens.

The work described above has been carried out as part of the research programme of the National Physical Laboratory, and this communication is published by permission of the director of the Laboratory.

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July 18.

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The Lambda Wave as a Normal Physiological Phenomenon in the Human Electroencephalogram

Several recent communications[1,2] have described a hitherto unobserved phenomenon in the human electroencephalogram. This consists of random monophasic waves ('lambda waves'), appearing when the eyes are open, in the occipital or parietal regions. The phenomenon is believed to be rare, and a relationship to pathological conditions such as epilepsy or organic disease of the brain has been suggested. We have, however, recently obtained evidence suggesting that it is probably a normal physiological phenomenon which may be frequently unobserved owing to its very low voltage, its masking by background activity or both.

In the course of an investigation of the electroencephalogram changes produced by pre-frontal leucotomy, waves were observed after the operation which were identical with those described by Evans, in form and distribution, but considerably greater in amplitude (Fig. 1). A re-examination of the series of records obtained in each case revealed, however, that in two-thirds of the patients the phenomenon was already present, though at lower amplitude in the barbiturate record before operation. Moreover, in a small proportion of patients it was seen in the electroencephalogram recorded in the waking state before and after leucotomy.

In the group of psychiatric patients investigated there was little reason for anticipating any abnormality either in the barbiturate record or in the ordinary electroencephalogram. It seemed worth while, therefore, to look into the possibility that the occipital lambda wave might be a physiological phenomenon present at a low though variable amplitude in the normal subject, and rendered more prominent by barbiturate anæsthesia and, for a period, by pre-frontal leucotomy. This unmasking of an activity absent from the electroencephalogram in

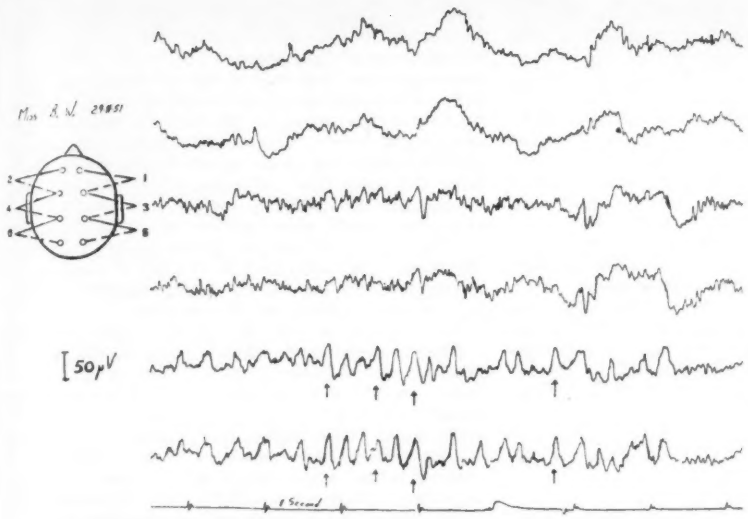

Fig. 1. Electroencephalogram under barbiturate anæsthesia showing prominent lambda waves in the occipital areas (marked with arrows in places) in a patient eight days after prefrontal leucotomy

however, can be elicited in many cases only with the use of special methods of examination. Confirmation for this view has been obtained by a recent observation of lambda waves during ordinary sleep in one normal subject and five psychiatric patients. That the waves we have observed in the barbiturate record are homologous with those described by Evans is suggested by (*a*) their similarity in form; (*b*) their random arrhythmic character; (*c*) the fact that when the phenomenon is located in the parietal, occipital or parieto-occipital regions in the waking state, their distribution is nearly always identical in the barbiturate record (Fig. 2).

the waking state, or its enhancement when present during consciousness at low voltage, is a well-known effect of barbiturate anæsthesia on some other phenomena in the electroencephalogram[3,4].

Electroencephalograms of thirty-seven normal adult subjects whose ages ranged from sixteen to fifty-six have been studied. Special attention was paid to the effects of long periods of maintaining the eyes open, of stimulation with a flickering light, visual scanning of plain, patterned and printed cards, and of attention and mental effort. Lambda waves were found in the waking state in twenty-seven of the thirty-seven subjects. In the majority of these the phenomenon was present in poorly sustained form at very low amplitude and was distinguished with difficulty from background activity. But opening the eyes following 20–30 sec. of stimulation with a flickering light at about twenty flashes per second evoked the phenomenon for 4–6 sec. in a more clearly defined form and at higher voltage in most subjects. Six of the subjects, two of them with, and four without, the lambda waves in the waking state, have been examined under light barbiturate anæsthesia (0·25 gm. sodium thiopentone). Lambda waves were demonstrated in the barbiturate record of all six subjects. In the two subjects whose ordinary records had shown lambda waves, the latter were greatly increased in amplitude in the barbiturate record, though identical in form with those observed in the waking state.

The findings suggest that the lambda waves are a physiological phenomenon in the human electroencephalogram which,

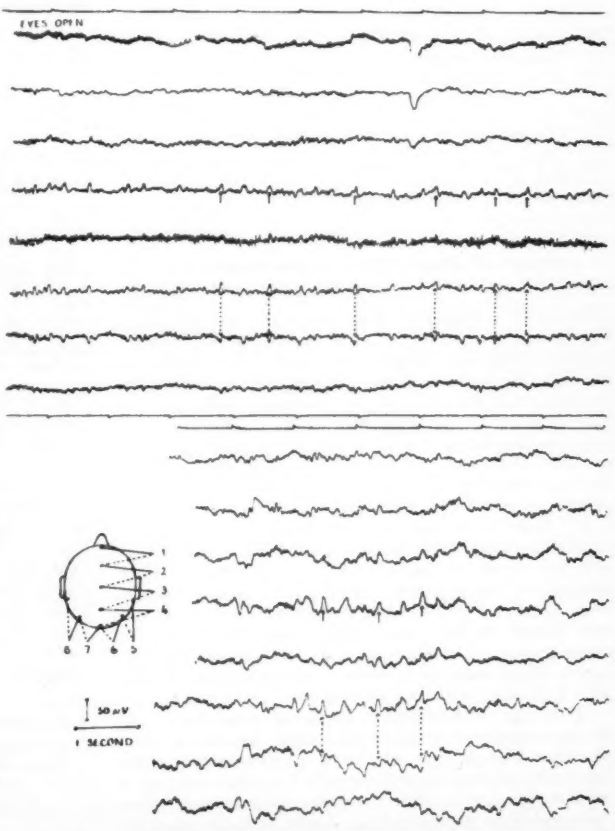

Fig. 2. Records taken during consciousness (above) and under light barbiturate anæsthesia (below) showing occipital sharp waves of similar distribution and a phase-reversal between leads 6 and 7 in each case

The phenomenon is suppressed when the room is darkened or the patient asked to focus on a near object or to gaze at a plain white surface. But looking at a patterned or printed card did not consistently evoke or enhance the phenomenon as in Evans's experiments. When the patient was asked to scan a patterned or printed card as in reading, the phenomenon was almost invariably evoked or augmented; but it was reduced on scanning a sheet of white paper. The same result was obtained with either eye covered. The results would appear at first sight to confirm Evans's view that the waves are provoked by abrupt changes in the afferent impulses that occur as the focus of macular vision moves over areas of varying brightness. But the relationship with macular stimulation, if any, does not appear to be a specific one even during consciousness. Thus we have repeatedly observed the appearance of the phenomenon following cessation of the mental effort involved in solving a problem. The presence of lambda waves at enhanced amplitude during barbiturate anæsthesia is also evidence against any specific association with visual perception or hallucination[3] or mental activity. However, these problems, as also the apparent change in the prominence of lambda waves after pre-frontal leucotomy, are matters for further investigation.

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Effect of Melanophore Hormone on Regeneration of Visual Purple in Solution

Jores[1] considered that melanophore hormone might have a role in night vision, first because nocturnal animals have more melanophore hormone in their hypophysis than diurnal ones; secondly, because the amount of the hormone increases on dark-adaptation; and thirdly because, apart from the hypophysis, the hormone is concentrated only in the eye and thalamus. He presumed that the function of the hormone was to act as a catalyst for the regeneration of visual purple.

By injecting a highly purified fraction of melanophore hormone subcutaneously, I have shown[2] that this hormone not only shortens the time of dark adaptation but also considerably increases the sensitivity in man. Furthermore, the melanophore hormone was found[3] to have an augmentative effect on the regeneration of visual purple *in situ*, using Japanese toads (*Bufo vulgaris formosus*) into the lymph heart of which the hormone was injected.

Although melanophore hormone accelerates the *in vivo* regeneration of visual purple, we do not know whether this is due to direct participation in the regenerative process or indirectly by influencing some retinal condition (for example, blood circulation) favourable to regeneration. Some experiments have accordingly been carried out to ascertain how the hormone would act on visual purple itself. At least five frogs (*Rana nigromaculata*) were decapitated after two hours of dark-adaptation and the eyes enucleated and dissected equatorially under a dim red light in a dark room. The visual purple was extracted with 2–3 ml. of sodium-cholate solution. The extract was divided into three equal portions. To two of these portions was added a certain volume of distilled water, while to the third was added a similar volume of melanophore hormone (extracted from the hypophyses of male and female frogs and containing about 50 I.U. per ml.). Each portion of the visual purple solution was then neutralized with 0·1–0·2 ml. of 0·1 *M* phosphate buffer. All three solutions were then exposed to 1,500 lux for 10 sec., which reduced the visual purple content to about 75 per cent of that initially present.

Immediately after bleaching, the portion containing melanophore hormone and one of the control portions were incubated in the dark, the other control portion being used for a determination of visual purple content. After incubation for about two hours the amounts of visual purple in the other portions were determined. The amounts of visual purple present were obtained by measuring the change in density occurring on exposure to light. The density measurements were made near the absorption maximum using a filtered light of dominant wave-length 517 mμ (bandpass width, more than 20 per cent transmitted; 460–588 mμ)[3]. The results obtained are shown in the table.

Exp. No.	Vol. of melanophore hormone added to visual purple solution	Visual purple bleached	Visual purple regenerated			
			Control		Proof	
			Opt. density	Per cent	Opt. density	Per cent
5	0·2–0·65 ml.	0·052	0	0	0·003	5·8
6	0·1–0·4	0·041	0·007	17·1	0·011	26·8
7	0·1–0·4	0·047	0·007	14·9	0·032	68·1
8	0·2–0·5	0·042	−0·006*	−14·3	0·013	31·0
9	0·2–0·5	0·059	−0·003*	− 5·8	0·016	27·1
10†	0·2–0·5	0·013	−0·002*	−15·4	0·020	153·8
11†	0·2–0·5	0·052	−0·004*	− 7·7	0·007	13·5
12†	0·2–0·65	0·022	−0·002*	− 9·1	0·004	18·2
13†	0·3–0·7	0·069	−0·001*	−10·1	0·001	10·1
14†	0·1–0·25	0·014	−0·002*	−14·3	0·006	42·9

* Negative values indicate degeneration.
† In these experiments the visual purple was extracted from the outer segments of the rods by Kimura's method (ref. 4).

It is clear from the table that whereas in the controls the amount of visual purple is either only slightly increased, or it may even be degenerated during the incubation period, some regeneration always occurs in those solutions containing melanophore hormone and always to a greater extent than in the controls. This indicates that melanophore hormone has an effect on the regenerative process. The very large amount of regeneration observed in experiment No. 10 suggests that there may exist some factor which co-operates with melanophore hormone very effectively. A study of the effect of various factors on the potency of melanophore hormone is now in progress.

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Effect of Rauwolscine on the Action of Adrenaline on Blood Pressure

RAUWOLSCINE ($C_{21}H_{26}O_3N_2$), the active principle of *Rauwolfia canescens*, has been isolated by Chatterjee, and its chemical nature has been studied[1,2]. The pharmacology of this alkaloid has recently been investigated by Mukherjee and Sen[3,4]. This compound has been found to be hypotensive. I have observed that the intravenous injection of 1 mgm. per kgm. of body weight of rauwolscine completely annuls the action of adrenaline on blood pressure in cats when injected intravenously in 1 c.c. doses of 1 : 100,000, 1 : 50,000, 1 : 20,000 and 1 : 10,000 strengths of adrenaline. This antagonistic action of rauwolscine to adrenaline has also been studied on amphibian and mammalian isolated heart muscles by perfusion technique. The normal amphibian and mammalian hearts are always stopped when perfused with 1 c.c. of 1 : 1,000 of adrenaline (P.D.). These hearts cannot be revived. 1 c.c. of 1 : 20,000 dilution of rauwolscine can, however, check this toxic action of adrenaline on the heart. Rauwolscine cannot counteract the glycogenolytic action of adrenaline. The mechanism of action of rauwolscine against adrenaline is now being investigated in detail.

I am indebted to Prof. A. Chatterjee, professor of chemistry, Lady Brabourne College, for kindly supplying the rauwolscine for this experiment.

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A New Type of Autonomic Blocking Agent

THE useful autonomic ganglionic blocking agent hexamethonium, and some of its closely related derivatives, possess quaternary ammonium nitrogen atoms. The activity of the compounds of this type has commonly been associated with the quaternary ammonium salt structure. Certain side-effects of drugs of this type may also be attributed to their quaternary salt nature. In exploring a series of compounds related to *W.R.L.* No. 51–143, 1-methyl-3-(δ-dimethylaminobutyl)piperidine dihydrochloride, it was discovered that powerful ganglionic blocking activity is also possessed by tertiary amines. The importance of this discovery lies in the facts that not only are these tertiary amines at least as potent and much less toxic than hexamethonium derivatives, but also, lacking the quaternary salt groups of the latter compounds, they should be free of many of the aforementioned side-effects.

On intravenous injection in anæsthetized cats and dogs, *W.R.L.* No. 51–143 blocks the autonomic ganglia and causes falls in blood pressure comparable to those obtained with hexamethonium chloride. Injected epinephrine is not blocked. On oral administration, equimolar doses of *W.R.L.* No. 51–143 last longer than hexamethonium in lowering the blood pressure.

Other tertiary amines and quaternary ammonium salts of the same series are also being investigated. Detailed pharmacological and chemical reports on this group of substances will be made elsewhere.

Extensive work is in progress to exploit these findings by the examination of numerous other related series of compounds of quite varied structures.

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Urinary Excretion of Acid and Neutral Deoxyribonuclease by Rats under Normal and Post-Irradiation Conditions

INTEREST in devising methods of studying tissue breakdown after irradiation has led us to investigate the deoxyribonucleases in body fluids on the premise that these enzymes are liberated only by damaged or destroyed cells. We have reported previously on the increased urinary excretion of the neutral deoxyribonuclease by rats exposed to lethal doses of X-rays[1]. The purpose of the present communication is to describe a similar but more prompt increase in the urinary excretion of an acid deoxyribonuclease (*p*H optimum 5·6) by irradiated rats. This is the enzyme which has been studied recently *in extenso* by Allfrey and Mirsky[2]. It has been found in many tissues, especially those capable of active proliferation. The urinary acid deoxyribonuclease is partially inhibited by magnesium ion and citrate (0·1 *M*); its activity is not affected by antimony sulphate, sodium arsenate and extract of the pigeon crop gland, all of which inhibit the neutral deoxyribonuclease[3,4].

In our experiments, twelve-hour samples of urine were collected from the experimental rats before and after total-body exposure to 700 roentgens of 250-kV. X-rays[1]. The urine was diluted with an equal volume of a 1 : 100 (v/v) aqueous solution of the chelating agent, versene, in order to remove magnesium ions. One ml. of the diluted urine was buffered with 1·5 ml. of a 0·2 *M* acetate buffer (*p*H 5·6), and the solution was incubated with 0·5 ml. of a highly polymerized solution of sodium deoxyribonucleate prepared according to the method of Kay and Dounce[5]. The enzymatic reaction was stopped after three hours of incubation at 37° C. by addition of 0·8 ml. of 3·6 *M* trichloracetic acid, and the deoxypentose phosphorus was determined in the supernatant fluid of the centrifuged solution. The following data demonstrate the marked increase in the deoxyribonuclease activity after irradiation of 10 rats:

DEOXYRIBONUCLEASE ACTIVITY

	Range	Average
Before irradiation (12 hr., 1 day pre-exposure)	3·50– 7·03	4·92
After irradiation (6–18 hr. post-exposure)	15·96–33·96	28·20

The deoxyribonuclease activity is calculated for the twelve-hour collection period and is expressed as acid-soluble deoxypentose-phosphorus released per hour of incubation at 37° C.

Our results leave no doubt that there are two deoxyribonucleases in rat urine, and that the activities of both enzymes increase after total-body exposure of the animals to X-rays. These findings strongly suggest that the increased activity, particularly of the acid enzyme, is related to the destruction of radiosensitive cells.

This work will be published elsewhere in greater detail.

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A Disturbance of Tryptophan Metabolism in Congenital Hypoplastic Anæmia

The clinical entity originally designated as congenital hypoplastic anæmia[1] and more recently termed erythrogenesis imperfecta[2] is a rare type of anæmia characterized by an erythroid hypoplasia of the bone marrow, by normocytic and normochromic circulating red cells, and by the lack of response to any of the known erythropoietic agents. In the course of some metabolic studies conducted on one such patient whose anæmia was diagnosed shortly after birth and who had been studied for four years by one of the authors (G. M.), a strongly bluish-fluorescent substance was noted in the urine. (This patient has been studied through the kindness of Dr. C. P. Katsampes.) This fluorescent material was identified as anthranilic acid by chromatographic methods[3], isolation from the patient's urine, and by spectroscopic techniques. The R_F of this fluorescent material was 0·90 in butanol : acetic acid : water, 1 : 1 : 5, in agreement with the R_F of a known sample of anthranilic acid. The melting point of the material isolated (144–146°) and the absorption spectrum are identical with comparable data reported in the literature for anthranilic acid.

Oral administration of 1·6 gm. of L-tryptophan led to increased urinary excretion of anthranilic acid as well as to the excretion of other intermediary metabolites of tryptophan.

On the basis of the available knowledge concerning tryptophan metabolism it was reasoned that anthranilic acid was most likely to accumulate in excessive amounts under conditions of riboflavin deficiency. This point of view has recently been confirmed by the work of Charconnet-Harding *et al.*[4] and Mason[5]. In order to test the validity of this postulate, the patient in question was treated with massive doses of riboflavin per os (200 mgm. per day for 17 days and then 100 mgm. per day for 13 days). Although no change in the hæmatological status was observed even after one month under this therapeutic regimen, there appeared to be a decrease in the amount of anthranilic acid excreted.

Specimens from eight additional cases have been made available to us and in all instances anthranilic acid could be found in the urine. (Specimens of urine from cases studied elsewhere were furnished through the kindness of Drs. I. A. B. Cathie, L. K. Diamond, E. Freshman and C. H. Smith.) In one case (specimen and information on the case furnished by Dr. L. K. Diamond) experiencing hæmatological improvement nine weeks after splenectomy, anthranilic acid was still detectable in the urine. Urinary specimens collected at random on the pædiatric ward revealed no case in which anthranilic acid was detectable in the urine.

The findings reported here are suggestive of an inborn error in tryptophan metabolism. The relationship of this metabolic disturbance to the co-existing anæmia has, as yet, not been elucidated. Studies aimed at exploring this point are now in progress. The genetic disturbance, if such exists, may be pleiotropic in nature. None of the members of the immediate family of the patient studied was found to excrete the metabolite in question. Details of this work will be published elsewhere.

This paper is based in part on work performed under contract with the U.S. Atomic Energy Commission at the University of Rochester Atomic Energy Project, Rochester, New York.

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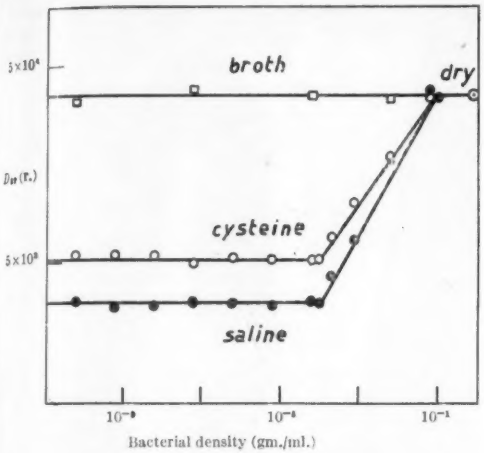
Quantitative Aspects of the Indirect Action of X-Radiation at Various Concentrations on *E. coli*

The lethal effects of irradiations with X-rays on *E. coli* have been studied. Our observations were made on bacteria dried, or suspended either in 2 per cent broth or saline solution, at bacterial densities of 10^{-1} to 10^{-10} gm./ml. Some experiments were also made by adding 10^{-3} *M* cysteine to the solutions. An X-ray tube was used operating at 110 kV., and 4 m.amp., at a dose-rate of 36 r./min., without any additional filter.

The overall configuration of the curves paralleled that observed by other authors on tobacco mosaic virus[1], rabbit papilloma virus[2] and *S*-13 *coli* phage[3]. Our results can be partly explained on the basis of widely accepted theories. On the dry bacteria and strongly concentrated suspensions, the effect is only direct; as the concentration is diminished (in the absence of broth), both direct and indirect effects occur. If the suspending medium contains cysteine, the indirect action is reduced; it disappears if the medium contains broth.

There is no clear explanation of the observation that the dose giving 36·8 per cent survival (D_{37}) is independent of the bacterial concentration, at extremely diluted cell suspensions. The hypothesis (Lea[4], p. 317), that the 'death' of a bacterium is due to a direct effect only, cannot be accepted under the conditions of our experiments. The marked difference between the D_{37} for irradiated dry bacteria and for those in water, as well as the chemical protection, necessarily require an explanation of the absence of



variability of the D_{37} for diluted suspensions within the limits of the indirect effect, taking into account the constant probability of a direct action. Therefore the 'dilution effect' during irradiation of bacteria at lower cell concentrations ceases to be a suitable criterion for distinguishing one mechanism from the other.

In other experiments that will be published *in extenso* elsewhere, it was observed that the effects of a constant amount of hydrogen peroxide (tested for concentrations of 10^{-2} to 10^{-6} M) against bacterial density (from 10^{-3} to 10^{-6} gm./ml.) are not the same quantitatively as the effects of a constant dose of radiation. In the light of these results, we do not think that a biological activity (such as the *E. coli* catalase activity) can partly neutralize the chemical effects of radiations in such a way as to justify the quantitative characteristics observed. Moreover, the observed behaviour of the D_{37} cannot be explained on the basis of the kinetics of radical recombination[4,5].

If we consider each element separately and its relationship with the free active radicals, it is possible to offer an interpretation. Taking into account the indirect effect only, we observe that the absolute weight of bacteria reacting with a given dose diminishes from 10^{-1} to 10^{-4} gm./ml. of bacterial density, owing to the recombination of free radicals. Radical combination increases progressively, but in a lesser degree than the diminution of the bacterial density; consequently, the relative effectiveness of radiation is enhanced. This appears to be due to the fact that, by decreasing the bacterial density, each individual cell is subjected to the action of an increasing number of active radicals. But this effectiveness does not increase indefinitely. At a given cell concentration a limit would be reached, which represents the maximum indirect action for a given number of active radicals. It can be assumed that the lower inflexion of the D_{37} line (corresponding to 10^{-4} gm./ml. for the *E. coli*) is related to the distance between the separate entities. According to this interpretation, the point of inflexion is to be expected at a higher concentration when the irradiated object is larger. In the light of the above results and of the experimental results[1-3], there would appear to be a relationship between the critical concentration and the size of the cell. If this quantitative relationship is independent of the nature of the irradiated object as well as of the characteristics of the chemical changes which cause the observed effect, analogous behaviour is to be expected by irradiating chemical substances of various molecular weights.

Further studies on the behaviour of micro-organisms in comparison with chemicals of different molecular weight are being undertaken to substantiate the hypothesis.

Fuller details of this work will be published elsewhere.

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Morphogenetic Interaction between Embryonic Mouse Tissues separated by a Membrane Filter

In analysing inductive interaction between parts of developing systems several investigators[1] have interposed barriers of various sorts to distinguish between effects due to direct cellular contact and those due to diffusion. No morphogenetic effect has been demonstrable in particular cases through 'Cellophane', vitelline membrane or cigarette paper. In studies of epithelio-mesenchymal interaction in cultured mouse embryo rudiments we have recently employed so-called membrane or molecular filters[2] for similar purposes and have noted two morphogenetic effects across them. The present brief report is to record these results as a suggestion of possible broader usefulness of filters of this type in problems of embryonic induction.

Thirteen-day-embryo submandibular and eleven-day-embryo metanephric rudiments of the mouse can be separated into epithelial and mesenchymal components following 5–10 min. exposure to 3 per cent trypsin (desiccated powder, 1 : 300, in calcium–magnesium-free Tyrode's solution)[3]. An epithelial component explanted in a cluster with mesenchyme fragments from its own rudiment type (autogenous) undergoes morphogenesis in characteristic fashion; a similar component explanted with generalized mesenchyme or mesenchyme from other rudiments (heterogeneous) forms only a spheroidal mass or simple cyst. On the other hand, eleven-day-embryo metanephric mesenchyme (nephrogenic cord), which forms tubules during normal development under the influence of the metanephric epithelium (ureteric bud), produces coiled tubules when combined in culture with its own epithelium, submandibular epithelium or embryonic spinal cord, but fails to do so when cultured in isolation.

To test for possible diffusible effects in these interactions, appropriate tissues have been cultured on either side of 4-mm. square molecular filter sheets (Millipore, *HA*, 20 μ thickness, Lovell Chemical Co., Watertown, Mass.). (I am grateful to Drs. Glenn Algire and Richmond Prehn, of this Institute, for

bringing the filters to my attention, and to W. B. Krabek, of the Lovell Chemical Co., for supplying test material.) Fragments of one tissue were placed on the surface of a chicken plasma clot, covered with the filter, and fragments of the second tissue superimposed over the first in a second clot on top of the filter. The 20-μ filter is sufficiently translucent to allow accurate superimposition of the two tissues.

The culture vessels were small, flat, loosely covered glass dishes with a central well in which the clot (rooster plasma and nutrient fluid, 1 : 1) was made. Over the clot was layered supernatant nutrient fluid containing horse serum, Tyrode's solution and chick embryo juice (2 : 2 : 1). The supernatant fluid, which included 5 mgm. per cent each of penicillin and streptomycin, was replaced every second day. The covered dishes were incubated at 37·5° C. in containers filled with 5 per cent carbon dioxide in air. The procedure, which gave good morphogenesis of early intact rudiments, appears to combine certain of the advantages of the watch-glass and Carrel flask techniques.

The behaviour of submandibular epithelium directly recombined with its own mesenchyme, or separated by a filter from its own or heterogeneous mesenchyme, is shown in Fig. 1. When isolated from

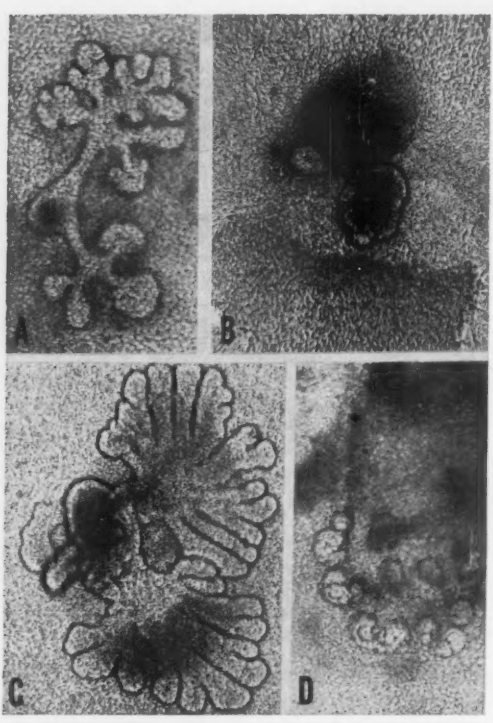

Fig. 1. *A*, Submandibular epithelium undergoing morphogenesis in culture after isolation and recombination with autogenous mesenchyme. Third day of culture. (× 32)
B, Submandibular epithelial rudiment on top of filter, heterogeneous (from maxillary region of 13-day embryo) mesenchyme below. Third day in culture. No morphogenesis, final product an inflated cyst. (× *c.* 27)
C, Submandibular epithelial rudiment on top of filter, autogenous mesenchyme below. Definite but atypical morphogenesis. Fourth day in culture. (× *c.* 27)
D, 13-day-embryo spinal cord fragment (out of focus) on top of filter, coiled tubule rudiments forming below in metanephric mesenchyme. Fourth day in culture. (× 32)

Fig. 2. Fixed and stained cross-section through heterogeneous mesenchyme (left), filter (centre) and epithelial rudiment (right). This is the same culture as in 1,*B*, fixed on sixth day. (× 340)

mesenchyme the epithelium spreads as a thin sheet or, at most, forms abortive processes; with heterogeneous mesenchyme on the opposite side of the filter it rounds into a cyst; with autogenous mesenchyme on the opposite side of the filter (Fig. 1 *C*) it undergoes process formation of variable morphology, reminiscent of, but clearly differing in detail from, the characteristic *in vitro* behaviour (Fig. 1 *A*). It thus appears that, without direct cellular contact (Fig. 2), mesenchyme can prevent spreading and disorganization of the epithelial rudiment and, depending on the specific character of the mesenchyme, alter the epithelial morphogenetic behaviour. It is of interest, however, that autogenous mesenchyme separated from epithelium by a filter does not, on the basis of present results, produce reactions equal to those produced by directly associated autogenous mesenchyme.

While it is clear that heterogeneous mesenchyme exerts a filter-passing inhibitory influence on submandibular morphogenesis, it is not yet clear whether autogenous mesenchyme exerts filter-passing positive morphogenetic effect. Such an effect is noted, however, when thirteen-day embryo spinal cord fragments are placed on one side of the filter with metanephric mesenchyme fragments on the other. In a significant number of cases coiled tubules, similar to those forming in the mesenchyme of intact cultured metanephric rudiments and in metanephric mesenchyme directly combined with embryonic spinal cord, appear in the mesenchyme above the filter (Fig. 1 *D*).

It thus appears that membrane filters, now becoming available in various thicknesses and

porosities, may prove a useful tool for disentangling and characterizing the diffusible and non-diffusible components of inductive processes.

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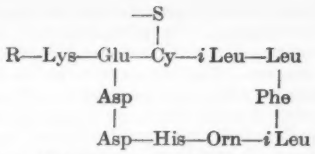
Structure of Bacitracin *A*

A BACITRACIN polypeptide purified by charcoal chromatography was shown by ultracentrifugation to have a molecular weight of 1,400–1,500 [1]. Recently, by a modified procedure using milder conditions, a peptide of higher antibiotic potency (about 60 units/mgm.) was isolated from a cruder starting material than was previously used. Except for higher activity, this peptide has essentially the same properties as that previously studied. This preparation was compared with a specimen of bacitracin *A*[2] kindly supplied by Dr. L. C. Craig, and appears to be identical with it. Ultracentrifugation of bacitracin *A* indicated a somewhat lower molecular weight (1,390), but the difference is probably not significant. The most potent fraction obtained from charcoal will therefore be referred to as bacitracin *A*.

Independently of Newton and Abraham[3] and Craig *et al.*[4], I found that the sulphur atom is probably involved in a labile heterocyclic structure, possibly a thiazoline or thiazolidine ring. In any event, no —S—S— bridges were found by polarography and no indication of dimerization was detected by ultracentrifugation during conditions where this was expected to occur. With the exception of ornithine and histidine, all the amino-acids present in bacitracin *A* were found in hydrolysate from the fully substituted DNP derivative. Lysine was found to be unaffected by Sanger's reagent[5]. No DNP-leucine or DNP-*iso*leucine was found (contrary to the findings of Newton and Abraham), and the method of Edman[6] did not reveal any N-terminal amino-acid. These facts indicate the cyclic nature of bacitracin and the presence of heterocyclic rings.

In order to obtain further information about the structure, bacitracin *A* was partially hydrolysed by 6 *N* hydrochloric acid for 72 hr. at 37° C. The resulting peptide mixture was fractionated by successive application of zone electrophoresis and charcoal and paper chromatography. The details of the methods will be published elsewhere. Many of the peptides yielding glutamic and aspartic acids and cystine on hydrolysis were difficult to isolate. After evaporation of the solvent, these peptides often are converted to insoluble products. Complete hydrolysis of a ninhydrin-positive substance (obtained by partial hydrolysis) gave only lysine and an unknown compound which is ninhydrin-negative (but gives a yellow spot on paper chromatograms after heating). The ε-amino group of lysine must therefore be linked to this, as yet, unidentified compound. The observations indicate that the amino-acids of bacitracin are interconnected in the following order:



The lysine, glutamic acid and cysteine residues are not necessarily linked together in a straight peptide chain but are probably participants in a heterocyclic ring system. This could explain the formation of some intermediate hydrolysis products. Although I feel that the amino-acid sequence is not definitely established, there seems to be little doubt that the distribution of amino-acids in the bacitracin *A* molecule is highly asymmetrical. It is quite certain that the molecule consists of a lipophilic and a lipophobic part. Moreover, the uneven distribution of basic and acidic amino-acids makes the lipophilic part strongly polar. The antibiotic activity is probably primarily associated with the labile heterocyclic ring system and possibly with the *d*-amino-acids. Full biological potency may depend upon the asymmetrical shape of the molecule.

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An Antifungal Substance from a Strain of *B. subtilis*

THOUGH a considerable literature has accumulated regarding the antibacterial action of *B. subtilis*, less attention has hitherto been paid to the antifungal action of the bacillus[1]. In the course of our investigation on the occurrence and isolation of antibiotic-producing micro-organisms from soil and infected foodstuff, an effort was made to collect different strains of the bacillus which would produce substances showing antifungal action especially against plant pathogenic fungi. The report of one such strain *B* (*X*) isolated from decomposed foodstuff and identified according to Bergey[2] is recorded here.

The bacillus was grown both in potato–peptone broth and yeast extract–sucrose broth at 30° C. for five days in shallow layers of 30 ml. in 500-ml. Erlenmeyer flasks. The culture filtrate was heated for 15 min. at 60°–70° C. The active principle was precipitated by acidification with dilute hydrochloric acid, or isolated more effectively by extracting the culture filtrate with *n*-butanol and evaporating the extract at 60°–70° C. *in vacuo*. The residue was repeatedly washed with water, the wash-liquor discarded, and the product was purified further by dissolving it in alcohol and reprecipitating with ether. when an orange-white precipitate was obtained. The solution was kept overnight at 4° C., centrifuged and the precipitate dried to give a dark-yellowish mass.

The substance was found to be insoluble in dilute hydrochloric acid but soluble in ethanol, butanol,

dilute sodium hydroxide and 5 per cent sodium bicarbonate solution. It gave negative tests with Fehling's solution, 2,4-dinitrophenyl hydrazine and Ehrlich's reagent. No coloration was obtained with ferric chloride. The substance gave positive biuret and ninhydrin tests; Millon's reagent gave a faint pink coloration.

When kept at 4° C. the antibiotic retained its activity for more than three months. It was found to be stable when autoclaved at 120° C. for 10 min. but less so in alkaline solution. The antifungal action of the substance as determined by the agar cup and agar streak methods is shown in Table 1.

Table 1

Test organisms	Minimum inhibitory conc. (μgm./ml.)
1. *A. niger*	12·0
2. *P. notatum*	12–15·0
3. *A. oryzae*	20–25·0
4. *Alternaria solani*	25·0
5. *Pythium* sp.	200·0
6. *Fusarium* sp.	30·0
7. *B. cinerea*	15·0

It was also active against *Curvularia* sp., *Verticillium* sp., *Phoma* sp., *P. rotundum* and *Trichophyton* sp., but inactive against *Epidermophyton* sp. and *Microsporum* sp. at a concentration of 0·2 mgm./ml.

The substance was thus found to possess a broad antifungal spectrum, but little action was shown against the bacteria tested, namely, *Staph. aureus*, *E. coli*, *V. cholerae*, *K. pneumoniae*, *Eb. typhosa* and *Strept. haemolyticus*.

The antibiotic appeared to be homogeneous, as single spots moving near the solvent front were revealed on the paper chromatogram when tested with ninhydrin, and also microbiologically by using *n*-butanol – acetic acid – water or ethyl alcohol – water mixture (R_F about 0·67) as the developing solvent. The potentiometric titration of the substance with sodium hydroxide gave a pK of about 5·8.

Since the antibiotic was thought to be a polypeptide in nature, its acid-hydrolysate was subjected to both one- and two-dimensional paper chromatography[2] using phenol – water and benzyl alcohol – acetic acid – water (25 : 5 : 6·5) mixtures as solvents. The following amino-acids were revealed on the chromatogram: aspartic acid, glutamic acid, serine, threonine, alanine, tyrosine, *nor*valine, phenylalanine, and two unidentified spots near aspartic acid and phenylalanine respectively. The maximum intensity of the spot due to serine indicated predominance over the others. Glutamic acid was, however, found to be present in minute quantity.

The antibiotic was found to be strongly hæmolytic, and 50–100 mgm. of the substance per kgm. body-weight injected subcutaneously to mice was tolerated with difficulty. Further toxicity tests were not attempted in consideration of its strong hæmolytic action. The incorporation of 10 per cent horse serum in the assay medium partly diminished the activity of the substance against *A. niger*.

The substance differs from bacillomycin, mycosubtilin and fungistatin, which are known antifungal products of *B. subtilis*, in its antifungal and anti-bacterial activities. It appears to differ from bacillomycin by its very low content of glutamic acid, relative preponderance of serine and presence of a larger number of amino-acids in the acid-hydrolysate. It seems to resemble the incompletely characterized '*Aspergillus* factor' in its anti-microbial properties. Details of this work will be published elsewhere.

P. Nandi
G. P. Sen

Microbiological Laboratory,
Bose Institute, Calcutta 9.
March 17.

[1] Landy, M., Harren, G. H., Rosenham, S. B., and Colio, L. G., *Proc. Soc. Exp. Biol. and Med.*, **67**, 539 (1948). Tint, H., and Reiss, W., *J. Biol. Chem.*, **190**, 133 (1951). Walton, R. B., and Woodruff, H. B., *J. Clin. Invest.*, **28**, 924 (1949). Hobby, G. H., *et al.*, *J. Clin. Invest.*, **28**, 927 (1949); "Ann. Rev. Biochem.", **20**, 390 (1951). Michener, H. D., and Snell, N., *Arch. Biochem.*, **22**, 208 (1949). Babad, J., *et al.*, *Nature*, **170**, 619 (1952).

[2] "Bergey's Manual of Determinative Bacteriology" (6th edit., 1948).

[3] Burma, D. P., *J. Ind. Chem. Soc.*, **28**, 555 (1951).

Fungistasis in Soils

The work recently described by Dobbs and Hinson[1], suggesting the occurrence of a widespread fungistasis in soils, prompts us to describe certain observations we have made of a somewhat similar nature.

Soil water was displaced from several soils with alcohol. This was assayed for fungistatic activity by a serial dilution assay using *Botrytis allii*[2] as a test organism, which we have found more sensitive to antibiotics than most soil fungi. On several occasions growth was retarded in 1 : 2 and 1 : 4 dilutions, though germination was not inhibited; distortion of germ-tubes similar to that produced by griseofulvin[3] was sometimes seen.

'Cellophane' bags containing activated charcoal were buried at various locations and depths at Wareham Heath; after a period of 36 hr., these were dug up, the charcoal extracted with ether, the solvent evaporated and the residue dissolved in water. Fungistatic activity similar to that in displaced soil water was again observed on several occasions.

Slabs of water agar, or agar buffered at *p*H 7 with phosphate–citrate buffer, were placed in intimate contact with the face of sloping soil-profiles at Wareham Heath for about 36 hr. Within six hours of removal, these slabs were processed in one of two ways: either they were uniformly covered with a thin film of Czapek agar seeded with *B. allii* spores, or strips or cylinders removed with a cork borer were placed on suitable agar plates seeded with *Bacterium coli*, *Bacillus subtilis* or *Botrytis allii*. The impression gained from several such experiments was that the agar slabs after exposure to the soil acquired localized areas of inhibitory activity, inhibition of all test organisms being observed at one time or another. The agar was in all cases contaminated with soil organisms; but the time during which these could have grown was not considered to be sufficient for them to have produced substances in the agar which could have caused the inhibitions seen, nor did the growth of contaminants coincide with the areas of inhibition.

None of these methods can be considered to be as sensitive as that of Dobbs and Hinson, since in each case some degree of dilution was involved and added nutrient was always present; but the traces of antibiotic activity detected were probably real and indicative of a more intense activity *in situ*. It is noteworthy, however, that our observations suggest discontinuous 'islands' of inhibition rather than a widespread 'sea' of inhibition. It is true, of course,

that the inhibition we have observed may be quite different in character and origin from that observed by Dobbs and Hinson.

E. G. Jefferys
H. G. Hemming

Butterwick Research Laboratories,
Imperial Chemical Industries, Ltd.,
Welwyn, Herts.
Sept. 9.

[1] Dobbs, C. G., and Hinson, W. H., *Nature*, **172**, 197 (1953).
[2] Brian, P. W., and Hemming, H. G., *Ann. App. Biol.*, **32**, 214 (1945).
[3] Brian, P. W., Curtis, P. J., and Hemming, H. G., *Trans. Brit. Mycol. Soc.*, **29**, 173 (1946).

A Rhesus Monkey with *B* Agglutinogen in the Erythrocytes

Previous studies on rhesus monkeys[1] showed that the serum contained an anti-*A* but no anti-*B* agglutinin; the erythrocytes, on the other hand, lacked the expected *B* agglutinogen. Group specific substance *B* could, however, be found in secretions and organ extracts[2].

I intended to demonstrate to my students this apparent deviation from the rule of reciprocal relationship between anti-*A* and anti-*B* agglutinins and *A* and *B* agglutinogens, when recently, through the kindness of Dr. S. L. Hora, director of the Zoological Survey of India, I was fortunate enough to get a sample of clotted blood from a female rhesus monkey (*M. mulatta*) about eight years old. The animal had been shot and the blood was taken from the heart immediately afterwards.

The serum was separated from the clot, centrifuged and inactivated. Tests with human blood cells of the four groups proved, as expected, the presence of anti-*A* in the monkey's serum.

The blood corpuscles, washed once, were suspended in normal saline to form a 2 per cent concentration. Tests were arranged first with ordinary human antisera of equal strength. Anti-*B* quickly produced a very strong agglutination, whereas anti-*A* only after about 15 min. resulted in forming a weak agglutinate.

In order to remove the heteroagglutinins for animal blood, purified agglutinin solutions were prepared according to the technique outlined by Wiener[3]. Again the rhesus blood cells were tested. Purified anti-*A* did not show any reaction, whereas with anti-*B* a clear strong clumping was obtained.

This result was unexpected. The possibility theoretically exists that a heteroagglutinin through non-specific absorption (*Sekundärbindung*[4]) to the *B*-beta complex might have been transferred to the purified anti-*B* solution. Therefore absorption experiments were carried out in order to verify the findings. Three drops of packed rhesus cells, washed once, were added to each 1 c.c. human anti-*A* and anti-*B* and left in the refrigerator overnight. The absorbed sera were then tested against known cell suspensions along with the unabsorbed sera as controls. The results are given in the accompanying table.

Serum	Test cells	Serum dilutions 1	2	4	8	16
Anti-*A* unabsorbed	*A*	+++	+++	++	+	−
„ absorbed with *rh*-cells	*A*	+++	++	++	+	−
Anti-*B* unabsorbed	*B*	+++	++	++	+	−
„ absorbed with *rh*-cells	*B*	±	−	−	−	−

Anti-*A* serum absorbed and unabsorbed both had a titre of 8. The absorption did not affect the strength of this agglutinin. Anti-*B* before absorption had also a titre of 8, but after absorption even in undiluted condition it was only strong enough to agglutinate partially the erythrocytes. The fluid between the very small clumps remained pink-coloured. Unfortunately, through an accident, no rhesus blood cells were left for checking if anti-*B* could be completely removed from the human serum.

The absorption tests thus confirm the results obtained with purified solutions. One could, however, assume that the anti-*B* serum used for the tests contained an unusually strong heteroagglutinin against rhesus blood, and further, that the reaction between heteroagglutinin and monkey cells through non-specific absorption simultaneously removed the anti-*B*. This argument can be rejected, as the titre of the serum was about the same for monkey and human cells. Non-specific absorption, if it occurs at all, causes only a small diminution in the titre of the heterologous agglutinin. The great difference in strength of absorbed and unabsorbed anti-*B* could thus not be the consequence of non-specific absorption. Moreover, for purified solutions and for absorption, different anti-*B* sera were used, and it is unlikely that both sera contained a similar unusually strong heteroagglutinin.

It may therefore be inferred from these facts that a rhesus monkey was found which possessed a *B* or a *B*-like agglutinogen in its erythrocytes.

E. C. Büchi

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Calcutta 13.
June 26.

[1] Buchbinder, L., *J. Immunol.*, **25**, 33 (1933). Wiener, A. S., Gavan, J. A., and Gordon, E. B., *Amer. J. Phys. Anthrop.*, **11**, 39 (1953).
[2] Candela, P. B., Wiener, A. S., and Goss, L. J., *Zoologica*, **25**, 513 (1940).
[3] Wiener, A. S., "Bloodgroups and Transfusion", 27 (1943).
[4] Thomsen, O., and Worsaae, E., cited by Dahr, P., "Die Technik der Blutgruppen- und Blutfaktorenbestimmung", 207 (1948).

First Record of the Rare Beaked Whale, *Mesoplodon europaeus*, Gervais, from the West Indies

On February 21, 1953, two small female whales came close inshore in Bull Bay, in the parish of St. Thomas, Jamaica, and were beached by local fishermen. I had the opportunity of examining them some eight and a half hours later, through the courtesy of Mr. A. Thomas, the Government fisheries officer. Preliminary investigation showed that they belonged to the group of beaked whales, and it was thought that they might be true two-toothed whales although the teeth were neither visible nor could they be felt through the gums. Upon removal of the flesh and examination of the skulls, the specimens were tentatively identified as *Mesoplodon europaeus*, Gervais, on the basis of the key to the species of *Mesoplodon* given by Raven[1]. Dr. Remington Kellogg of the Smithsonian Institution, U.S. National Museum, very kindly examined photographs of both the intact animals and the prepared skulls and confirmed this identification.

So far as I am aware, this capture marks the fifth and sixth specimens of *M. europaeus* to be recorded. The first and type specimen (described from the skull only) was found in the English Channel in 1840, the

second on the coast of New Jersey in 1889, the third at Long Island in 1933, and the fourth at Middle Key, Florida, in 1935.

The larger of the two specimens was dissected on the beach, and the internarial epiglottis, the reproductive organs, portions of the kidney and certain glandular structures were removed and fixed. The mammary glands exuded milk when cut, and the uterus appeared to be in a semi-stretched condition, which suggested that this larger specimen was a lactating female which had given birth to a calf not many weeks previously. It may have been the mother of the younger specimen; but as very little is known of the reproductive habits of these forms, it is difficult to determine this with any certainty.

Careful dissection in the area surrounding the vent did not lead to the discovery of any pelvic bones; but it was noticed that a broad band of tough fibrous tissue was present in the region where one would normally expect to find the small pelvic bones. After being partially dissected, the specimens were removed to the Zoology Department of the University College of the West Indies, where the work of preparing and mounting is still being done.

A brief description therefore follows, and details of the osteology and certain soft parts will be described in a later paper when the skeletons are fully prepared.

Colour. Both animals were black dorsally, merging into a dark grey ventrally which had a pinkish tinge in it. A slightly lighter grey area in the region of the mammary folds corresponded with that described as whitish in Raven's specimen. The pectoral fins and tail flukes were all of a uniform black colour. A number of small light-coloured scarified areas were present, probably due to rolling in the surf over boulders in the process of beaching.

Form. The body contours followed very closely those described by Raven for his Long Island specimen; and in particular the exceptional width of the flukes was noted. The two long gular grooves of the larger whale were seen, a feature which Raven did not have an opportunity of noting in his specimen. The dorsal fin was set well back on the body.

Measurements. The external measurements of the larger specimen were as follows:

Tip of snout to notch of tail fluke	426·7 cm.
Tip of snout to posterior rim of blow hole	57 cm.
Tip of snout to eye	57 cm.
Tip of snout to posterior border of base of pectoral fin	119·4 cm.
Middle of dorsal fin to notch of tail fluke	155 cm.
Length of upper jaw from tip of snout to angle of mouth (over curves)	33 cm.

A detailed comparison of the skulls of the two Bull Bay specimens with those mentioned in Raven's paper shows that the larger of the two whales compares closely in proportions with the Long Island specimen, which is also a female and probably of approximately the same age. The smaller one is apparently much younger than the Atlantic City male whale—the skull being only 460 mm. in total length in comparison with the 675 mm. of the latter specimen. This small specimen therefore represents an earlier growth-stage and is the youngest *M. europaeus* to be recorded. As Raven points out, the tendency in Odontocœtes is for the females to be larger than the males, and so the difference in age between the Atlantic City and the Bull Bay specimens is probably even greater than the measurements would at first sight suggest. The bones of the skull of the latter specimen are extremely fragile, some are incompletely ossified, especially in the rostral region, and the sutures are still widely open. As this calf is obviously not very old, it is tempting to speculate that the breeding ground of these whales may not be far away from the Caribbean.

J. J. Rankin

Department of Zoology,
University College of the West Indies,
Mona, St. Andrew,
Jamaica.
May 15.

[1] Raven, H. C., *Amer. Mus. Novitates*, **905**, 1 (1937).

An Aquatic Larva, suitable for Laboratory Work

The larva of the caddis fly, *Setodes tineiformis* Curtis (Trichoptera, Leptoceridæ), has recently been described by me[1] from material obtained from a large artificial lake in Surrey. It was found to breed freely if the adults were confined to the top of an aquarium with muslin. It has an annual life-cycle and the larvæ construct cases entirely of a labial secretion the size and appearance of a hedgehog quill.

The larva swims well, pulling its case behind, and the movement of the body can be watched through the transparent case. It will remain alive for three or four days packed in wet waterweed (not moss) for postal transportation, or for two or three weeks with only sufficient water to cover in a Petri dish. It requires only an abundance of any of the usual water weeds with their epiphytic algæ for aeration and food.

N. E. Hickin

Plummers,
Bletchingley,
Surrey.
July 24.

[1] Hickin, N. E., *Proc. Roy. Ent. Soc. Lond.*, A, **28**, 74 (1953).

Occurrence of *Asparagopsis armata* Harv. on the Coast of Devon

Records of the distribution of the red alga *Asparagopsis armata* Harv. have indicated a spread of the species from the southern hemisphere. The first collections in the northern hemisphere were at Saint Eugène, Algeria, in 1923, and Guéthary, France, in 1925[1]; the species was reported in Ireland in 1942[2]. The plant was first recognized on the coast of Britain in 1950, when Drew[3] found numerous specimens cast up on the beaches of the Lizard Peninsula, and in 1951 Horridge[4] reported attached specimens in the Scilly Isles.

In August and September 1953, specimens of *Asparagopsis armata* were found at Wembury Beach and Bovisand Bay, South Devon; in both places the plants were attached, bore no reproductive organs and grew above mean low-tide level. The presence of *Asparagopsis* at these points indicates an eastward spread of the species along the south coast of Britain.

Joy Kerslake

Biology Department,
Northern Polytechnic,
London, N.7.
Sept. 17.

[1] Sauvageau, C., *C.R. Acad. Sci., Paris*, **180** (1925).
[2] de Valera, M., *Irish Nat. J.*, **8**, 30 (1942).
[3] Drew, K. M., *Nature*, **166**, 873 (1950).
[4] Horridge, G. A., *Nature*, **167**, 732 (1951).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 9

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. J. M. Houston: "Economic Development in French and Spanish Morocco".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. N. Tinbergen: "The Biological Study of Animal Behaviour: its Possibilities and its Limitations".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "What are the Requirements of Electrical Engineering Textbooks?"

Tuesday, November 10

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 2.15 p.m.—Mr. Turner Cooper: "The Control and Removal of Surplus Water in the Soil".

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS, LONDON CENTRE (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. S. Welch: "The Influence of Signal Imitation on the Design of V.F. Signalling Systems".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

COMMUNICATION RESEARCH CENTRE (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Communication as a Biological Phenomenon"*.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP and OILS AND FATS GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. I. H. Chayen and Mr. D. R. Ashworth: "The Application of Impulse Rendering to the Animal Fat Industry".

INSTITUTION OF THE RUBBER INDUSTRY, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 7 p.m.—Mr. D. S. Berry: "The Stress Relaxation Method of Assessing Ageing Resistance".

ROYAL AERONAUTICAL SOCIETY (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. J. Taylor: "Gusts and their Measurement".

Tuesday, November 10—Wednesday, November 11

INSTITUTE OF PHYSICS, ELECTRON MICROSCOPY GROUP (at Birkbeck College, Malet Street, London, W.C.1)—Annual Conference.

Wednesday, November 11

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Air Pollution and the London Fog of December, 1952", opened by Dr. E. T. Wilkins.

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. E. P. Fairbairn: "Some Aspects of the Design of V.H.F. Mobile Radio Systems".

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. J. W. Jenkins, Mr. J. H. Evans, Mr. G. A. G. Wallace and Mr. D. Chambers: "A High-Definition General Purpose Radar".

OVERSEAS SCIENCE STUDENTS ASSOCIATION (at the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Sir Alexander Fleming, F.R.S.: "The Search for Antibiotics".

BRITISH SOCIOLOGICAL ASSOCIATION (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Mr. R. B. Buzzard: "Attendance and Absence in Industry".

Thursday, November 12

PHYSICAL SOCIETY, OPTICAL GROUP (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 2.30 p.m.—Dr. G. B. Arden and Dr. R. A. Weale: "The Latent Period of Vision and the Pulfrich Effect".

EAST MALLING RESEARCH STATION (at Withersdane, Wye College, near Ashford, Kent), at 4 p.m.—Prof. R. H. Stoughton: "Some Aspects of the Growth and Development of Fruit Plants"* (Amos Memorial Lecture).

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. A. H. Wilson, F.R.S.: "The Research Department of Courtaulds Limited".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Safety Precautions in Electronic Apparatus, with Particular Reference to Medical Applications".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 6 p.m.—Mr. J. G. Wimpenny: "Stability and Control in Aircraft Design".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Dr. J. G. Davis: "The Microbiology of Different Types of Cheese".

Friday, November 13

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 9.45 a.m.—Symposium on "Cathodic Protection".

ASSOCIATION OF APPLIED BIOLOGISTS (in the Physics Laboratory Building, Royal Fort, University of Bristol, Bristol), at 11 a.m.—Scientific Papers.

POSTGRADUATE MEDICAL SCHOOL OF LONDON (at Ducane Road, Shepherd's Bush, London, W.12), at 4 p.m.—Dr. L. G. Pugh: "The 1953 Everest Expedition".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

BEDSON CLUB (in Lecture Theatre II, The Chemical Laboratories, King's College, Newcastle-upon-Tyne 1), at 5.30 p.m.—Dr. A. F. Wells: "The Third Dimension on Chemistry".

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Prof. L. C. Burrill and Mr. Arnold Emerson: "Propeller Cavitation: Some Observations from 16-in. Propeller Tests in the New King's College Cavitation Tunnel".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. K. A. G. Mendelssohn, F.R.S.: "A New State of Aggregation".

Saturday, November 14

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, St. Mary's Hospital Medical School, Paddington, London, W.2), at 11.30 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SCIENTIST, Grade 3 (with good honours degree in science (physics or chemistry)), IN THE DUST SUPPRESSION SECTION of the Divisional Scientific Department, National Coal Board—Divisional Chief Scientist, National Coal Board, Northern (N. and C.) Division, The Grange, Grange Avenue, Longbenton, Newcastle-upon-Tyne (November 7).

RESEARCH ASSISTANT (with first- or second-class degree in physiology, biochemistry or chemistry, or A.R.I.C.) IN THE DEPARTMENT OF CHEMICAL PATHOLOGY of the United Bristol Hospitals—The Secretary to the Board, Royal Infirmary Branch, Bristol 2 (November 14).

SENIOR PHYSICIST (with honours degree or equivalent, and at least five years experience in the gas or chemical industries) with the West Midlands Gas Board, Area Laboratories, Birmingham, for duties including physical determinations and investigations, and the supervision of such work—The Industrial Relations Officer, West Midlands Gas Board, 6 Augustus Road, Edgbaston, Birmingham 15 (November 14).

ASSISTANT, Grade B (with good academic qualifications and experience in physical chemistry), IN CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (November 16).

DEMONSTRATOR (honours graduate in chemistry or biochemistry) IN CHEMICAL PATHOLOGY—The Registrar, The University, Leeds (November 16).

DEMONSTRATOR IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Leeds 2 (November 16).

LABORATORY TECHNICIAN (preferably with experience in biophysical or physical-chemical laboratories) to work with the electron microscope and ultracentrifuge—The Secretary, The Foot-and-Mouth Disease Research Institute, Pirbright, Surrey (November 16).

SENIOR LECTURER or LECTURER IN BOTANY, and a LECTURER IN GEOGRAPHY, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (November 16).

LECTURER or ASSISTANT LECTURER (with good degree in mining and preferably a first-class certificate of competency) IN MINING, and a RESEARCH ASSISTANT (with good degree in mining engineering or pure science) TO THE PROFESSOR OF MINING—The Registrar, The University, Sheffield (November 20).

ASSISTANT LECTURERS (2) (one with special qualifications in horticulture, and the other with a special interest in biochemistry) IN BOTANY—The Registrar, The University, Manchester 13 (November 21).

ASSISTANT PHYSICIST (with honours degree in physics, and preferably with experience in research work) at Saint Luke's Hospital, Dublin—The Secretary, The Cancer Association of Ireland, "Oakland", Highfield Road, Rathgar, Dublin, quoting "A.P." (November 21).

CHEMIST (with H.S.C. (science) or equivalent, but degree or H.N.C. in chemistry may be an advantage) at the Royal Ordnance Factory, Blackburn, to supervise staff engaged on chemical and physical analysis of materials and some mechanical testing—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.514/53A (November 21).

ASSISTANT LECTURER IN PHYSICS—The Registrar, Queen Mary College, Mile End Road, London, E.1 (November 27).

ASSISTANT LECTURER IN PHYSICS—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (November 28).

SCIENTISTS and ENGINEERS (with degree or equivalent in science or engineering) in the Scientific Department of the National Coal Board to carry out environmental studies at Collieries in connexion with a long term field research into the occurrence and causes of pneumoconiosis—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/700 (November 28).

LECTURER (with special interest in organic chemistry) IN CHEMISTRY—The Secretary of University Court, The University, St. Andrews (November 30).

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, The University, Manchester 13 (November 30).

LECTURER or ASSISTANT LECTURER IN CIVIL ENGINEERING at the University College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (November 30).

SCIENTIFIC OFFICER or a SENIOR SCIENTIFIC OFFICER (with good honours degree in biochemistry, or registered veterinary surgeon, and preferably with research experience in the metabolism of farm animals) IN THE BIOCHEMISTRY DEPARTMENT—The Secretary, Moredun Institute, Gilmerton, Edinburgh 9 (November 30).

CHAIR OF ORGANIC CHEMISTRY—The Secretary, Queen's University, Belfast (December 3).

LECTURER or SENIOR LECTURER IN ZOOTECHNY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, December 5).

CHAIR OF ORGANIC CHEMISTRY tenable at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 36 North Bailey, Durham (December 7).

DAIRY OFFICER (with degree in dairying, and preferably with experience in pasteurization of milk, and knowledge of cream grading for butter manufacture) in the Department of Agriculture, Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (December 15).

LECTURER IN GEOGRAPHY (Grade 1), and a LECTURER IN MATHEMATICS (Grade I) at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth 5, Gordon Square, London, W.C.1 (December 15).

LECTURER IN GEOGRAPHY—The Secretary, The University, Aberdeen (December 30).

PROFESSOR OF TEXTILE CHEMISTRY—The Registrar, College of Technology, Manchester (December 31).

HUNTLEY AND PALMERS AGRICULTURAL RESEARCH FELLOWSHIP, for independent research in some branch of agriculture, dairying or horticulture, or the sciences related thereto—The Registrar, The University, Reading (January 23).

READER IN PATHOLOGY at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, January 31).

ASSISTANT ENGINEERS (with recognized university degree or diploma in civil engineering carrying exemption from Sections I and II of the A.M.I.C.E. examinations, and with at least two years approved practical experience, or A.M.I.C.E.) in the Public Works Department, Tanganyika—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.112/8/03.

ASSISTANT, Grade A (with university degree in science, and prepared to teach two or more of the following: botany, zoology, chemistry and general food science to Inter.B.Sc. standard) IN THE DEPARTMENT OF FOOD TECHNOLOGY—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

ASSISTANT LECTURER IN AGRICULTURAL ZOOLOGY—The Bursar, Royal Agricultural College, Cirencester.

DIRECTOR (with first- or second-class honours degree in a pure science, and with considerable postgraduate experience in microbiological research) OF THE COLONIAL MICROBIOLOGICAL RESEARCH INSTITUTE, Trinidad—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/38/01.

HYDRAULIC ENGINEERS (with university degree or diploma in civil engineering carrying exemption from Sections I and II of the Institution of Civil Engineers' examinations, or be A.M.I.C.E.) in the Public Works Department, Kenya, for duties which will include investigation, design, construction and maintenance of township water supplies, development of rural water supplies and water conservation—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.112/7/02.

LECTURER (with good honours degree in mining engineering and a wide knowledge of mine ventilation and fluid mechanics) IN MINING ENGINEERING—The Registrar, The University, Nottingham.

PHYSICIST or ORGANIC CHEMIST (with research experience, and preferably with some knowledge of X-ray crystallography and/or coal or carbon research) for fundamental research on chemical and physical aspects of carbonization—The Clerk, Birkbeck College, Malet Street, London, W.C.1.

PHYSICISTS (recent graduates, with Ph.D. or equivalent) for work on electronics or physical measurements; METALLURGISTS (recent graduates, with Ph.D. or equivalent) for investigating fatigue failures, and other problems associated with the metal-working industries; and an ELECTRONICS TECHNICIAN to take charge of the instrumentation in connexion with problems in physics, chemistry and biology—Dr. G. M. Sarum, Director, British Columbia Research Council, Vancouver 8, Canada.

RESEARCH ASSISTANT in the field of physical chemistry (reaction kinetics)—The Registrar, University College, Exeter.

RESEARCH FELLOW or RESEARCH STUDENT (preferably with knowledge of electronics) for fundamental investigations of semi-conductors—The Registrar, The University, Nottingham.

RESEARCH OFFICER (with at least good second-class honours degree in botany, with training in genetics, and at least two years postgraduate experience in plant breeding, preferably in cereals) with the Maize Rust Research Scheme, Nigeria—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting 27059/320.

SCIENTIFIC OFFICER (with first- or second-class honours degree in inorganic or physical chemistry) at the National Physical Laboratory, Teddington, for research on analytical techniques in metallurgy—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.525/53A.

SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent in engineering, physics or mathematics, and good working knowledge of aerodynamics and/or engineering practice) in the Ministry of Supply, London Headquarters, to assist in administration of aerodynamic research programme, mainly concerned with rotating wings, and to contribute to initiation of new items of research and analysis of new projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1 quoting C.571/53A.

SENIOR RESEARCH ENTOMOLOGIST to take charge of research on cotton pests, at the Empire Cotton Growing Corporation's research station, near Kampala, Uganda—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with veterinary qualifications registrable in the United Kingdom, and basic training in hæmatology, pathology, chemotherapy and the principles of immunology, and in the case of Senior Scientific Officer at least three years postgraduate experience) to undertake duties of Veterinary Research Officer in the West African Institute for Trypanosomiasis Research—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.67/89/01.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Radio Research, Special Report No. 26: Measurements of Atmospheric Noise at High Frequencies during the Years 1945–1951. By F. Horner. Pp. iv+40. (London: H.M. Stationery Office, 1953.) 1*s.* 9*d.* net. [109

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1952. (With Index 1907–52.) Pp. 302+15 plates. (Bristol: The University, 1953.) 15*s.* [118

British Rubber Producers Research Association. Publication No. 180: Hydroperoxide Decomposition in Relation to the Initiation of Radical Chain Reactions. By L. Bateman, Mrs. Hilda Hughes and A. L. Morris. Pp. 190–199. (London: British Rubber Producers Research Association, 1953.) [119

Other Countries

Fisheries Research Board of Canada. Bulletin No. 97: The Eastern Belted Kingfisher in the Maritime Provinces. By H. C. White. Pp. iii+44. (Ottawa: Fisheries Research Board, 1953.) 45 cents. [109

Catalogue of Indian Insects. Part 27: Isoptera. By Dr. Rattan Lal and Dr. Ram Das Menon. Pp. v+94. (Delhi: Manager of Publications, 1953.) 7/2/- rupees; 11*s.* [109

Smithsonian Miscellaneous Collections. Vol. 119, No. 2: Permian Fauna at El Antimonio, Western Sonora, Mexico. By G. Arthur Cooper, Carl O. Dunbar, Helen Duncan, Arthur K. Miller and J. Brookes Knight. (Publication 4168.) Pp. iv+111+25 plates. Vol. 121, No. 10: The Tillodontia, an Early Tertiary Order of Mammals. By G. Lewis Gazin. (Publication No. 4109.) Pp. vi+110+16 plates. Vol. 122, No. 3: The Metamorphosis of a Fly's Head. By R. E. Snodgrass. (Publication No. 4133.) Pp. 25. Vol. 121, No. 11: Geological Background of the Iyatayet Archeological Site, Cape Denbigh, Alaska. By D. M. Hopkins and J. L. Giddings, Jr. (Publication No. 4110.) Pp. ii+33+4 plates. (Washington: Smithsonian Institution, 1953.) [109

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 104, 1952. Pp. iv+261+15 plates. 6.50 dollars to subscribers; 7.50 dollars to others. (Philadelphia: Academy of Natural Sciences, 1952.) [109

Notulæ Naturæ of the Academy of Natural Sciences of Philadelphia. No. 242: New and Interesting Species of Foraminifera from the Vincentown Formation. Part I: New Species. By James D. McLean, Jr. Pp. 13+3 plates. No. 243: Results of the Catherwood-Chaplin West Indies Expedition, 1948. Part VI: Amphibia and Reptilia. By Robert Sutcliffe. Pp. 8. No. 244: The Genus Achetaria (Scrophulariaceæ) of Lowland South America. By Francis W. Pennell. Pp. 4. No. 245: Professor A. E. Verrill's Freshwater Leeches—a Tribute and a Critique. By J. Percy Moore. Pp. 15. No. 246: Fishes from Deep Water off Southern Florida. By Henry W. Fowler. Pp. 16. (Philadelphia: Academy of Natural Sciences of Philadelphia, 1952.) [109

Smithsonian Institution: Institute of Social Anthropology. Publication No. 16: Penny Capitalism: a Guatemalan Indian Economy. By Sol Tax. Pp. x+230. (Washington: Government Printing Office, 1953.) [109

European Seminar and Lecture Course on Alcoholism. (Sponsored by the Royal Danish Government in co-operation with the World Health Organization and the United Nations; Copenhagen, 22 October–3 November, 1951.) Pp. x+121. (Geneva: World Health Organization, 1953.) [109

Problemi biologici e tecnologici della fecondazione artificiale. Da Prof. Telesforo. Pp. xv+506. (Istituto Sperimentale Italiano "L. Spallanzani." Per la fecondazione artificiale—Milano.) No. 7. (Milano: Istituto Sperimentale Italiano "L. Spallanzani," 1953.) 6000 lire. [109

U.S. Department of Commerce: Weather Bureau. Research Paper No. 36: Cloud Seeding Operations in the Bishop Creek, California, Watershed. By Ferguson Hall, T. J. Henderson and Stuart A. Cundiff. Pp. iv+29. (Washington: Government Printing Office, 1953.) 25 cents. [109

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